West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 4: Abundance estimates and marine community analyses of the data collected in partnership with the industry (Barry Group) in July 2005

F. Grégoire, W. Barry, J. Barry, C. Lévesque, J.-L. Beaulieu, and M.-H. Gendron

Department of Fisheries and Oceans
Science Branch
Maurice Lamontagne Institute
P.O. Box 1000, 850 Route de la Mer
Mont-Joli (Québec)
G5H 3Z4

2009

Canadian Technical Report of Fisheries and Aquatic Sciences 2837

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2009

WEST COAST OF NEWFOUNDLAND CAPELIN (*Mallotus villosus* M.) AND ATLANTIC HERRING (*Clupea harengus harengus* L.) LARVAL SURVEY, PART 4: ABUNDANCE ESTIMATES AND MARINE COMMUNITY ANALYSES OF THE DATA COLLECTED IN PARTNERSHIP WITH THE INDUSTRY (BARRY GROUP) IN JULY 2005

François Grégoire[1], William Barry[2], Jim Barry[2], Charline Lévesque[1], Jean-Louis Beaulieu[1], and Marie-Hélène Gendron[1]

[1]Department of Fisheries and Oceans
Science Branch
Maurice Lamontagne Institute
P.O. Box 1000, 850 Route de la Mer
Mont-Joli (Québec)
G5H 3Z4

[2]Barry Group, 415 Griffin Drive, Corner Brook, Newfoundland, A2H 3E9

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Cat. No. Fs 97-6/2837E ISSN 0706-6457

This publication should be cited as follows:

Grégoire, F., W. Barry, J. Barry, C. Lévesque, J.-L. Beaulieu, and M.-H. Gendron. 2009. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 4: Abundance estimates and marine community analyses of the data collected in partnership with the industry (Barry Group) in July 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2837: viii + 43 pp.

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ABSTRACT

Grégoire, F., W. Barry, J. Barry, C. Lévesque, J.-L. Beaulieu, and M.-H. Gendron. 2009. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, Part 4: Abundance estimates and marine community analyses of the data collected in partnership with the industry (Barry Group) in July 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2837: viii + 43 pp.

In partnership with the Barry Group in Corner Brook, a larval survey was conducted on the west coast of Newfoundland in July 2005. The survey's two principal objectives were to describe the spatial distribution and measure the abundance of eggs and larvae of the principal fish species occurring in the study area. The most abundant eggs belonged to the CYT group (cunner [*Tautogolabrus adspersus*] and yellowtail flounder [*Limanda ferruginea*]) followed by the H4B group (hake [*Urophycis* spp.], fourbeard rockling [*Enchelyopus cimbrus*] and butterfish [*Peprilus triacanthius*]) and the CHW group (Atlantic cod [*Gadus morhua*], haddock [*Melanogrammus aeglefinus*] and witch flounder [*Glyptocephalus cynoglossus*]). Among the larvae collected, the most abundant species were cunner, capelin (*Mallotus villosus*), fourbeard rockling and blenny (*Lumpenus* spp.) followed by righteye flounder (Pleuronectidae), Atlantic cod, Atlantic mackerel (*Scomber scombrus*) and windowpane flounder (*Scophthalmus aquosus*). Compared with the survey conducted in the same area in 2004, the 2005 survey was characterized by a significant drop in Atlantic herring (*Clupea harengus*) larvae and an increase of capelin and Atlantic mackerel larvae. Cluster and ordination analyses revealed the presence of a structure within the larval community. Groups of stations were defined and characterized mostly by the occurrence of cunner and capelin. Significant temperature and salinity differences were recorded between these groups. However, these differences were not large enough to show a link between the specific larval composition for each group of stations and these two environmental variables.

RÉSUMÉ

Grégoire, F., W. Barry, J. Barry, C. Lévesque, J.-L. Beaulieu, et M.-H. Gendron. 2009. West coast of Newfoundland capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus harengus* L.) larval survey, part 4: Abundance estimates and marine community analyses of the data collected in partnership with the industry (Barry Group) in July 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2837: viii + 43 pp.

En partenariat avec le Groupe Barry de Corner Brook, un relevé larvaire a été réalisé sur la côte ouest de Terre-Neuve en juillet 2005. Les deux principaux objectifs visés par ce relevé étaient de décrire la distribution spatiale des œufs et des larves des principales espèces de poissons présents dans la zone d'étude et de mesurer leur abondance. Les œufs les plus abondants ont été ceux du groupe CYT (tanche-tautogue [*Tautogolabrus adspersus*] et limande à queue jaune [*Limanda ferruginea*]) suivi du groupe H4B (merluches [*Urophycis* spp.], motelle à quatre barbillons [*Enchelyopus cimbrus*] et stromatée à fossette [*Peprilus triacanthius*]) et du groupe CHW (morue franche [*Gadus morhua*], aiglefin [*Melanogrammus aeglefinus*] et plie grise [*Glyptocephalus cynoglossus*]). Parmi les larves récoltées, les espèces les plus abondantes ont été la tanche-tautogue, le capelan (*Mallotus villosus*), la motelle à quatre barbillons et la lompénie (*Lumpenus* spp.) suivies des pleuronectidés, de la morue, du maquereau bleu (*Scomber scombrus*) et du turbot de sable (*Scophthalmus aquosus*). Par rapport au relevé réalisé dans la même région en 2004, celui de 2005 s'est caractérisé par une baisse importante de l'abondance des larves de hareng (*Clupea harengus*) et une hausse de l'abondance des larves de capelan et de maquereau bleu. Des analyses de groupement et d'ordination ont démontré la présence d'une structure au sein de la communauté larvaire. Des groupes de stations ont été définis et caractérisés principalement par la présence de la tanche-tautogue et du capelan. Des différences significatives de température et de salinité ont été mesurées entre ces groupes. Cependant, ces différences n'ont pas permis d'établir de liens entre la composition larvaire de chaque groupe et ces deux variables environnementales.

1.0 INTRODUCTION

An initial larval survey was conducted on the west coast of Newfoundland in July 2004, the main objectives of which were to describe the spatial distribution of capelin (*Mallotus villosus* M.) and Atlantic herring (*Clupea harengus* L.) larvae and to measure their abundance. In addition to these two species, eggs from three different species and three groups of species were identified during this survey as well as the larvae from 18 species (Grégoire et al., 2005). Biodiversity measurements revealed that the larval community structure at the time of the survey was characterized by the presence of a large number of scarce species and by commercial species concentrated in specific areas (Grégoire et al., 2006a). Groups of stations were characterized based on the presence of certain species. Significant differences in water temperature and salinity were measured between these groups. However, these differences were not large enough to show a link with the larval compositions of each group.

A second larval survey was conducted on the west coast of Newfoundland in July 2005. The eggs and larvae from most of the species previously observed in 2004 were once again sampled in 2005 (Grégoire et al., 2006b). Their spatial distribution is described in the current document. Biodiversity and abundance measurements are also presented and compared with results from the 2004 survey.

2.0 MATERIAL AND METHODS

2.1 Study area and sampling procedures

The survey was conducted between 19 and 21 July 2005 on board the commercial fishing vessel *Ocean Provider*. The area of coverage was south of Bonne Bay up to Port-au-Port Bay (Figure 1). A total of 39 stations were sampled using bongo nets (Posgay and Marak, 1980) with 333 micron and 500 micron mesh sizes. Two General Oceanics flowmeters were installed near the opening of the nets to measure the volume of water filtered. Tows followed a saw-tooth pattern (Hempel, 1973) between the surface and a maximum depth of 50 m, or down to 5 m off-bottom for shallower stations. A CTD probe (Sea-Bird Electronics, Inc.) was used to obtain temperature and salinity profiles. Samples from the 333 micron net were kept in a formaldehyde solution (4–5%) (Hunter, 1985) and those from the 500 micron net in an ethanol solution (95%).

2.2 Laboratory analyses

Plankton samples were analyzed according to the Van Guelpen beaker technique (Van Guelpen et al., 1982). The criteria used for identifying fish eggs and larvae are described in Fritzsche (1978), Elliott and Jimenez (1981) and Fahay (1983); we followed Girard (2000) for identifying the mackerel egg development stages. Egg and larva counts were standardized for volumes of 1,000 m^3 of water. Descriptive statistics were calculated on these values for all the species sampled.

2.3 Geostatistical abundance

Mean abundance data (number/1,000 m^3) for eggs and larvae from the most important

commercial species were estimated by ordinary kriging (Isaaks and Srivastava, 1989). The choice of variogram model and the calculation of the semi-variance were done with the GS^+ software (Robertson, 1998). A correction was applied on the constructed variograms for which extreme abundance values were discarded (Grégoire et al., 2006b). The kriging averages and their variances were calculated with the EVA II software (Petitgas and Lafont, 1997).

2.4 Accumulation (ACCUM) and dominance (DOMINANCE) plots

The ACCUM procedure from Primer (version 6.1.6) (Clarke and Gorley, 2006) was used to predict with three types of permutation (bootstrap, UGE and MM; Colwell and Coddington, 1994) the total number of species that should be observed if a very large number of stations had been sampled in the study area. The results from this procedure were compared to the actual total number of species observed.

The abundance and dominance of larval species were examined using the DOMINANCE procedure (Clarke and Gorley, 2006). For each station, larvae were ranked in decreasing order of abundance. Their relative abundance (i.e., percentage of the total abundance in the sampled station) was plotted against the increasing rank (x axis), the latter on a log scale. The y axis consisted of cumulative relative abundance.

2.5 Biodiversity measures (DIVERSE, DRAFTSMAN, MDS and PCA)

The structure of the larval community was described based on the total number of species (S) and larvae per station (N) and the following diversity indices: (1) Shannon (Legendre and Legendre, 1998), (2) Brillouin (Brillouin, 1956), (3) Fisher (Fisher et al., 1943), and (4) Margalef (Margalef, 1951). These indices, which are among the most widely used, help measure different attributes of the larval community (Clarke and Warwick, 2001). They were calculated and compared by pairs using the DIVERSE and DRAFTSMAN procedures (Clarke and Gorley, 2006). Their relative distances were measured using non-metric multidimensional scaling (MDS procedure; Clarke and Gorley, 2006) applied to the correlation matrix (absolute values x 100). Their relative importance was calculated using a principal component analysis (PCA procedure; Clarke and Gorley, 2006). The latter was applied to the standardized values from the indices to account for the scaling differences.

2.6 Marine community analyses

2.6.1 Similarity coefficient (RESEMBLANCE)

The Bray-Curtis (S_{jk}) similarity index was calculated between each pair of stations using the RESEMBLANCE procedure (Clarke and Gorley, 2006). This index is defined as follows:

$$S_{jk} = 100\left\{1 - \frac{\sum_{i=1}^{p}\left|y_{ij} - y_{ik}\right|}{\sum_{i=1}^{p}(y_{ij} + y_{ik})}\right\}$$

where y_{ij} represents the abundance of species i from station j (i=1,2,..., p; j=1,2,..., n) and y_{ik}, the abundance of species i from station k. The y_{ij} values were standardized by dividing the abundance of a species at one given station by the sum of all abundances from this same station to all stations.

2.6.2 Hierarchical clustering (SIMPROF and CLUSTER)

The occurrence of a structure within the larval community (larval assemblages) was tested using permutations (SIMPROF procedure; Clarke and Gorley, 2006). Groups of stations were defined from the Bray-Curtis similarities by hierarchical cluster analysis (CLUSTER procedure; Clarke and Gorley, 2006) according to the average association (UPGMA) (Legendre and Legendre, 1998). The significance of these groupings, which were considered *a priori* to be non-structured, was tested using SIMPROF.

2.6.3 Species contribution (SIMPER)

The importance of each larval species in the groups defined by cluster analysis and by SIMPROF was calculated using the SIMPER procedure (Clarke and Gorley, 2006). This procedure calculates each species' contribution from a group to the similarity of the group.

2.6.4 Non-metric multidimensional scaling (MDS)

Clarke and Warwick (2001) suggest that ordination techniques be applied to data that were previously used in a cluster analysis. Ordination is used in the presence of a regular gradient in an ecological community structure (McGarigal et al., 2000). According to Everitt (1978), non-metric multidimensional scaling represents the best ordination technique for describing in a small number of dimensions the complex relationships that may exist between members of an ecological community. Non-metric multidimensional scaling was applied to the similarity matrix using the MDS procedure (Clarke and Gorley, 2006).

The groups of stations defined by cluster analysis and SIMPROF as well as the abundance of species that have contributed the most to the similarity of each group were superimposed on the MDS procedure results.

2.7 Water temperature and salinity

Average temperature and salinity for the first 2, 5, 10 and 15 metres were calculated and compared between the groups defined by cluster analysis and SIMPROF. The first 10 m usually represents the layer of water above the thermocline (Grégoire et al., 2006b).

2.8 Similarity analysis between the 2004 and 2005 larval assemblages (ANOSIM and SIMPER)

The larval communities described in 2004 and 2005 were compared using a similarity analysis (ANOSIM procedure; Clarke and Gorley, 2006). A significant difference was measured and the species responsible were identified using SIMPER (Clarke and Gorley, 2006).

3.0 RESULTS

3.1 Stations and sampling characteristics

The Bay of Islands stations and the stations south of Bonne Bay (Figure 2) were the first to be sampled followed by those offshore in the direction of Port-au-Port Bay. The latter stations as well as those located near the coast towards Bay of Islands were sampled at the end of the survey. All the stations were sampled during the day at depths between 7 and 58 m (Table 1). The average tow length was 11 minutes and filtered volumes varied between 164 m^3 and 319 m^3 (average 256.4 m^3).

3.2 Egg distribution and abundance

Atlantic mackerel (*Scomber scombrus*) eggs were found at every sampling station (Table 2). Eggs from the CHW group (Atlantic cod [*Gadus morhua*], haddock [*Melanogrammus aeglefinus*] and witch flounder [*Glyptocephalus cynoglossus*]) and the CYT group (cunner [*Tautogolabrus adspersus*] and yellowtail flounder [*Limanda ferruginea*]) were found at 34 of the 39 stations compared to 27 stations for the H4B group (hake [*Urophycis* spp.], fourbeard rockling [*Enchelyopus cimbrus*] and butterfish [*Peprilus triacanthius*]). American plaice (*Hippoglossoides platessoides*) and windowpane flounder (*Scophthalmus aquosus*) were found at only 6 and 2 stations respectively.

The CYT group was the most abundant, with an average of 6,051.9 eggs/1,000 m^3 (Table 3). It was followed by the H4B group and the CHW group with respective averages of 395.1 and 374.8 eggs/1,000 m^3. An average of 316.2 eggs/1,000 m^3 was calculated for Atlantic mackerel compared to 1.5 and 0.8 eggs/1,000 m^3 for American plaice and windowpane flounder.

The abundance of eggs from Atlantic mackerel and the CYT group changed only slightly among stations (Figure 3). For the CHW group, higher abundances were measured at stations from the Bay of Islands region, whereas egg abundance from the H4B group was higher at the Bay of Islands and Port-au-Port stations.

3.3 Larval distribution and abundance

Between 4 and 12 larva species or groups of species were sampled during the survey (Table 4). The most frequently observed larvae were capelin, blenny (*Lumpenus* spp.), fourbeard rockling, cunner and Atlantic mackerel (30 stations and more). The most abundant species were cunner, capelin, fourbeard rockling and blenny, with 1,431, 833, 117 and 81 larvae/1,000 m^3 respectively, followed by righteye flounder, Atlantic cod, Atlantic mackerel and windowpane flounder with 65, 53, 27 and 23 larvae/1,000 m^3 (Table 5). The abundance of cunner and capelin varied only slightly among stations (Figure 4). The highest abundances of fourbeard rockling were recorded at the Port-au-Port Bay stations and at a few stations near the coast. The highest abundances of blenny were measured at the stations located between Bay of Islands and Port-au-Port Bay, at most of the stations located offshore for righteye flounder and offshore from Bay of Islands for Atlantic cod. The highest abundances of mackerel larvae were found at two stations located at the mouth of Bay of Islands. Windowpane flounder was mostly abundant in Port-au-Port Bay. For

other species such as herring, the highest abundances were measured at only a few stations located near the coast or offshore.

3.4 Abundance derived from geostatistics

The spatial variations in egg abundance of American plaice and of the CHW group were described using an exponential variogram compared with a spherical variogram for eggs from mackerel and from the H4B and CYT groups (Table 6, Figure 5). For larvae, the exponential model was only used for blenny. For all the models, the R^2 values varied between 0.71 and 1.0 and no anisometry was detected (Table 6).

Kriging maps for larvae illustrate well the spatial distribution of the corresponding species abundance (Figure 6). The average abundances calculated by kriging (Table 7, Figures 7A and 7B) were similar to the arithmetic averages (Tables 3 and 5). However, kriging considerably reduces the standard deviation. For capelin, mackerel and herring, the mean abundances were estimated at 738, 25 and 3 larvae/1,000 m^3.

3.5 Accumulation and dominance plots

The predicted values in terms of the total number of species that should have been observed became stable for a total number of stations similar to that of the survey (Figure 8A). Reaching such a plateau means that the larval community was properly sampled during the survey. The survey was also characterized by the dominance of only one species at nearly 30% of the stations (Figure 8B).

3.6 Biodiversity

The number of sampled species and the total number of larvae varied greatly among stations (Figures 9A and 9B). The same variations were also observed for the four other diversity indices (Figure 9C). The total number of larvae varied only slightly among stations. For the other indices, high values were observed at all the stations except for those at Port-au-Port Bay (Figure 10).

There are high correlations between the Fisher and Margalef and the Brillouin and Shannon indices (Figure 11A). These correlations are deduced by the proximity of these indices in a reduced space defined by non-metric multidimensional scaling (Figure 11B). This space is also characterized by the occurrence of a linear gradient with limits associated with the total number of larvae (N) and species (S).

The high correlations measured between the four previous indices are also deduced by the position of the vectors defined by the principal component analysis (Figure 11C). The first two components (PC1 and PC2) explain 66% and 24% of the total variance. The contributions (eigenvector) from each index to the first component are relatively the same size (between 27% and 47%). They are positive for the total number individuals and negative for the other indices. The total number of species and the total number of individuals contribute most to the second component (61% and 57% respectively).

3.7 Cluster analysis, ordination, and species contribution

The similarity profile presented a larger amount of high values than what the larval community with no internal structure hypothesis predicted (Figure 12A). The *Pi* statistic was significantly different ($P<0.001$) from a distribution associated with this hypothesis (Figure 12B). Six groups of stations were determined using cluster analysis and the SIMPROF procedure (Figure 13A). These groups were also observed in the reduced space defined by non-metric multidimensional scaling (Figure 13B).

Cunner was responsible for 96% of the similarity of group *a* (Figure 14). This species along with capelin and fourbeard rockling contributed 85, 8 and 5% respectively of the similarity of group *c*. Cunner and capelin contributed respectively 58 and 27% of the similarity of group *d* compared to 90% for capelin in group *e*. Finally, righteye flounder and blenny contributed respectively 26% and 22% of the similarity of group *f* whereas capelin and Atlantic cod each represented 16%. The stations associated with the two species (cunner and capelin) that most contributed to the similarity of their respective group occupied opposite positions in the space defined by non-metric multidimensional scaling. This structure is also highlighted when the abundance of these two species is superimposed on the MDS results (Figures 15A and 15B). The stations belonging to the groups defined by cluster analysis and ordination were not spatially grouped together, they were found throughout the study area (Figure 16).

3.8 Water temperature and salinity

Average temperatures that were calculated per group of stations (Table 8) all show significant differences (ANOVA; $P<0.0001$) for each depth class. For salinity (Table 9), significant differences were only observed for the first 10 and 15 metres (ANOVA; $P<0.0001$). For each water layer, the lowest average water temperatures were recorded for groups *e* and *f* and the highest for group *c* (Figure 17). Group *c* had the lowest average salinity levels (Figure 18).

3.9 Similarity analysis

The ANOSIM procedure indicated that the larval assemblages recorded in 2004 and 2005 were statistically different ($P<0.0001$) (Figure 19A). Capelin and cunner respectively contributed 61% and 9% of the similarity measured in 2004 compared with 54% and 26% for cunner and capelin in 2005 (Figure 19B).

4.0 DISCUSSION

Compared with the 2004 survey (Grégoire et al., 2006a), a larger number of Atlantic mackerel eggs and eggs from the CYT and CHW groups were sampled in 2005. However, there were fewer eggs from American plaice, windowpane flounder, and from the CHW group. Among the larvae from the principal commercial species, there was a significant drop for herring and an increase for capelin and mackerel. Larva abundances for righteye flounder and Atlantic cod remained relatively stable.

The occurrence of mackerel eggs and larvae in the samples collected on the west coast of

Newfoundland in 2004 and 2005 represented a certain element of surprise considering the location and the late sampling date. This region had never been covered by a larval survey, and it could be possible that mackerel spawn there every year. Using the same abundance assessment techniques used in the southern Gulf of St. Lawrence, spawning biomasses of 1,466 t and 5,692 t were calculated for 2004 and 2005 (Grégoire et al., 2008). These biomasses are much lower than in the southern Gulf. Nevertheless, they are relatively high considering the sampled area and the late survey dates.

The larval assemblages described in 2004 and 2005 were mainly characterized by capelin and cunner. These two species alone accounted for 70% and 80% respectively of the similarity associated with the 2004 and 2005 assemblages and for 56% of their dissimilarity. Over these two years, significant temperature and salinity differences were measured between the two groups of stations making up these assemblages. However, the analysis that was used (ANOVA) does not provide any link between the abundance of certain species at some stations and these two environmental variables. A multivariate approach could be used as well as the generalized additive models.

The larval survey on the west coast of Newfoundland was conducted for the industry and with their active collaboration. A third survey took place in 2007 and included Bay St. George. We plan to perform a daily population growth analysis of certain commercial species. These initiatives will better describe the marine ecosystem on the west coast of Newfoundland.

5.0 ACKNOWLEDGEMENTS

The authors would like to thank Dr. Yvan Lambert and Dr. Claude Savenkoff for the review of the report as well as the captain and crew of the *Ocean Provider* for their excellent collaboration.

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Table 1. Description of the stations and sampling of the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

STATION NUMBER	DATE (dd-mm-yyyy)	TIME OF THE DAY (hh:mm) (NDT)	LONGITUDE °W (degrees minutes)	LATITUDE °N (degrees minutes)	DEPTH Station bottom (m)	DEPTH Maximum sampled (m)	TOW DURATION (min:sec)	VOLUME OF WATER FILTERED (m^3)
1	19/07/2005	11:39	58° 12'	49° 09'	115	44	11:20	235
2	19/07/2005	12:36	58° 12'	49° 12'	112	39	11:03	230
3	19/07/2005	18:56	58° 12'	49° 27'	20	12	10:31	276
4	19/07/2005	18:19	58° 12'	49° 30'	35	29	11:26	269
5	19/07/2005	17:43	58° 12'	49° 33'	60	33	12:16	287
6	21/07/2005	14:21	58° 18'	49° 06'	70	53	11:20	292
7	21/07/2005	13:47	58° 18'	49° 09'	125	33	13:00	319
8	21/07/2005	13:12	58° 18'	49° 12'	145	36	11:46	295
9	19/07/2005	13:25	58° 18'	49° 15'	80	58	12:33	258
10	19/07/2005	14:05	58° 18'	49° 18'	21	8	11:35	277
11	19/07/2005	15:34	58° 18'	49° 21'	35	26	10:34	246
12	19/07/2005	16:07	58° 18'	49° 24'	45	35	11:35	270
13	19/07/2005	16:40	58° 18'	49° 27'	54	38	12:20	282
14	21/07/2005	12:26	58° 24'	49° 09'	45	34	12:24	290
15	19/07/2005	21:22	58° 24'	49° 12'	40	30	11:41	267
16	19/07/2005	20:45	58° 24'	49° 15'	40	30	11:48	280
17	19/07/2005	14:49	58° 24'	49° 18'	30	17	10:26	251
18	21/07/2005	11:23	58° 30'	49° 03'	45	37	12:10	303
19	20/07/2005	8:57	58° 30'	49° 06'	80	47	13:00	222
20	20/07/2005	8:23	58° 30'	49° 09'	80	43	09:45	172
21	20/07/2005	7:46	58° 30'	49° 12'	65	35	11:12	230
22	21/07/2005	9:33	58° 36'	48° 51'	44	34	10:00	240
23	21/07/2005	10:08	58° 36'	48° 54'	20	12	10:25	260
24	20/07/2005	11:42	58° 36'	48° 57'	34	26	10:18	238
25	20/07/2005	11:02	58° 36'	49° 00'	50	29	11:53	280
26	20/07/2005	10:24	58° 36'	49° 03'	45	31	12:09	268
27	20/07/2005	9:42	58° 36'	49° 06'	50	33	09:40	213
28	20/07/2005	18:15	58° 42'	48° 39'	27	26	10:50	265
29	20/07/2005	17:22	58° 42'	48° 45'	25	13	10:35	260
30	20/07/2005	16:07	58° 42'	48° 48'	15	12	10:37	274
31	20/07/2005	15:34	58° 42'	48° 51'	17	10	10:55	260
32	20/07/2005	13:13	58° 42'	48° 54'	25	21	10:22	194
33	20/07/2005	12:35	58° 42'	48° 57'	30	20	09:46	187
34	20/07/2005	19:01	58° 48'	48° 36'	20	16	10:52	309
35	20/07/2005	19:35	58° 48'	48° 39'	20	10	10:25	266
36	21/07/2005	7:55	58° 48'	48° 42'	17	7	10:42	289
37	20/07/2005	14:44	58° 48'	48° 48'	27	25	11:07	214
38	20/07/2005	14:04	58° 48'	48° 51'	40	30	10:34	164
39	20/07/2005	20:31	58° 54'	48° 51'	15	8	10:37	266
Mean					47.8	27.8	11:10	256.4
Std. Dev.					32.2	12.8	0:53	36.4
Minimum					15	7	09:40	164
Maximum					145	58	13:00	319
n					39	39	39	39

Table 2. List of egg taxa from the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

STATION	Atlantic Mackerel (*Scomber scombrus*)	H4B[1]	CHW[2]	CYT[3]	American Plaice (*Hippoglossoides platessoides*)	Windowpane flounder (*Scophthalmus aquosus*)	TOTAL
1	X	X	X	X			4
2	X	X	X	X	X		5
3	X	X	X	X			4
4	X	X	X	X			4
5	X	X	X				3
6	X	X	X	X			4
7	X	X	X	X	X		5
8	X	X	X	X			4
9	X	X	X	X	X		5
10	X	X	X	X			4
11	X		X	X	X		4
12	X		X				2
13	X	X	X				3
14	X	X	X	X		X	5
15	X	X	X	X	X		5
16	X	X	X	X			4
17	X	X	X	X			4
18	X	X	X	X			4
19	X		X	X			3
20	X		X				2
21	X		X				2
22	X	X		X			3
23	X	X	X	X			4
24	X	X	X	X			4
25	X		X	X			3
26	X		X	X			3
27	X	X	X	X	X		5
28	X	X	X	X			4
29	X	X		X			3
30	X	X	X	X			4
31	X		X	X			3
32	X		X	X			3
33	X		X	X			3
34	X	X	X	X		X	5
35	X	X		X			3
36	X	X		X			3
37	X		X	X			3
38	X		X	X			3
39	X	X		X			3
TOTAL	39	27	24	34	6	2	

[1]H4B = hake (*Urophycis* spp.), fourbeard rockling (*Enchelyopus cimbrius*) and butterfish (*Peprilus triacanthus*)

[2]CHW = cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and witch flounder (*Glyptocephalus cynoglossus*)

[3]CYT = cunner (*Tautogolabrus adspersus*) and yellowtail flounder (*Limanda ferruginea*)

Table 3. Abundance of eggs (number /1000 m^3) from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

STATION	American plaice	Atlantic mackerel	CHW (Cod, Haddock, Witch flounder)	CYT (Cunner, Yellowtail flounder)	H4B (Hake, Fourbeard rockling, Butterfish)	Windowpane flounder
1	0	119	477	2 248	34	0
2	35	334	730	7 122	139	0
3	0	1 020	232	16 346	290	0
4	0	283	1 288	30	22	0
5	0	178	773	0	21	0
6	0	408	158	3 315	55	0
7	6	326	244	11 543	0	0
8	0	509	434	3 200	271	0
9	4	637	279	1 335	31	0
10	0	778	144	52 817	115	0
11	4	394	975	227	0	0
12	0	259	828	0	0	0
13	0	145	1 056	0	43	0
14	0	503	482	9 615	62	7
15	4	528	719	809	30	0
16	0	406	242	834	7	0
17	0	988	64	1 530	191	0
18	0	465	145	8 285	53	0
19	0	99	1 586	433	0	0
20	0	99	1 162	0	0	0
21	0	61	766	0	0	0
22	0	179	0	9 960	58	0
23	0	492	8	9 167	19	0
24	0	504	42	11 986	42	0
25	0	714	57	13 733	0	0
26	0	340	359	4 065	0	0
27	5	207	639	451	38	0
28	0	102	60	11 786	2 020	0
29	0	169	0	12 746	1 229	0
30	0	204	36	20 432	525	0
31	0	116	15	11 029	0	0
32	0	284	62	62	0	0
33	0	133	64	64	0	0
34	0	29	6	1 167	1 997	26
35	0	71	0	1 324	1 926	0
36	0	52	0	6 099	2 218	0
37	0	145	205	1 865	0	0
38	0	49	280	67	0	0
39	0	4	0	331	3 974	0
Mean	1.5	316.2	374.8	6 051.9	395.1	0.8
Std. dev.	5.7	256.4	419.1	9 489.7	865.0	4.3
Minimum	0	4	0	0	0	0
Maximum	35	1 020	1 586	52 817	3 974	26
n	39	39	39	39	39	39

Table 4. List of larval taxa from the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

FAMILY	SPECIES	COMMOM NAME	STATION																		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ammodytidae	*Ammodytes* spp.	Sandlances			X																X	
Bothidae	*Scophthalmus aquosus*	Windowpane flounder						X		X										X	X	X
Clupeidae	*Clupea harengus*	Atlantic herring		X	X			X		X	X	X	X	X		X				X		
Gadidae	*Gadus morhua*	Atlantic cod	X	X	X	X	X		X	X		X	X	X	X	X	X	X		X	X	X
Labridae	*Tautogolabrus adspersus*	Cunner	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Liparidae	*Liparis* spp.	Snailfishes	X				X															
Osmoridae	*Mallotus villosus*	Capelin	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Phycidae	*Enchelyopus cimbrius*	Fourbeard rockling	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pleuronectidae	*Hippoglossoides platessoides*	American plaice														X						
Pleuronectidae	Pleuronectidae	Righteye flounder	X	X	X	X	X	X	X		X		X	X	X	X	X	X			X	
Pleuronectidae	*Pseudopleuronectes americanus*	Winter flounder		X	X	X	X		X	X	X					X	X					
Pleuronectidae	*Glyptocephalus cynoglossus*	Witch flounder								X						X		X		X		
Scombridae	*Scomber scombrus*	Atlantic mackerel	X		X			X	X	X	X	X	X	X		X		X	X	X	X	X
Scorpaenidae	*Sebastes* spp.	Redfishes							X	X	X											
Stichaeidae	*Stichaeus punctatus*	Arctic shanny			X	X																
Stichaeidae	*Ulvaria subbifurcata*	Radiated shanny			X							X				X						
Stichaeidae	*Lumpenus* spp.	Blenny	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	TOTAL		8	8	12	7	7	8	9	11	9	8	8	8	5	12	7	8	5	9	9	7

Table 4. (Continued).

FAMILY	SPECIES	COMMOM NAME	STATION																		TOTAL
			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
Ammodytidae	*Ammodytes* spp.	Sandlances																				2
Bothidae	*Scophthalmus aquosus*	Windowpane flounder		X	X	X			X	X	X	X	X		X		X	X			X	17
Clupeidae	*Clupea harengus*	Atlantic herring						X			X	X				X		X				15
Gadidae	*Gadus morhua*	Atlantic cod	X	X	X			X	X				X		X				X	X		26
Labridae	*Tautogolabrus adspersus*	Cunner	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	36
Liparidae	*Liparis* spp.	Snailfishes																				2
Osmoridae	*Mallotus villosus*	Capelin	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	38
Phycidae	*Enchelyopus cimbrius*	Fourbeard rockling	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	36
Pleuronectidae	*Hippoglossoides platessoides*	American plaice																				1
Pleuronectidae	Pleuronectidae	Righteye flounder	X	X	X	X	X	X	X			X	X			X			X	X		27
Pleuronectidae	*Pseudopleuronectes americanus*	Winter flounder		X										X								11
Pleuronectidae	*Glyptocephalus cynoglossus*	Witch flounder			X			X						X	X				X			9
Scombridae	*Scomber scombrus*	Atlantic mackerel	X	X	X	X	X	X	X	X	X	X	X				X	X	X		X	30
Scorpaenidae	*Sebastes* spp.	Redfishes													X							4
Stichaeidae	*Stichaeus punctatus*	Arctic shanny														X						3
Stichaeidae	*Ulvaria subbifurcata*	Radiated shanny		X	X	X			X		X	X	X	X	X			X				13
Stichaeidae	*Lumpenus* spp.	Blenny	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	37
	TOTAL		7	10	10	8	6	8	9	6	8	9	9	6	9	7	5	7	8	4	6	

Table 5. Abundance of larvae (number /1000 m^3) from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

STATION	American plaice	Arctic shanny	Atlantic mackerel	Capelin	Cod	Cunner	Fourbeard rockling	Atlantic herring	Redfish	Righteye flounder	Radiated shanny
1	0	0	4	64	17	21	13	0	0	72	0
2	0	0	0	3 509	9	161	4	4	0	9	0
3	0	22	51	276	73	327	174	7	0	109	15
4	0	11	0	22	15	0	15	0	0	33	0
5	0	0	0	52	10	7	0	0	0	21	0
6	0	0	31	322	0	1 479	27	3	0	55	0
7	0	0	66	225	6	1 703	75	0	3	6	0
8	0	0	68	5 316	14	1 356	136	7	7	0	0
9	0	0	8	411	0	559	16	4	4	16	0
10	0	0	29	50	29	2 451	43	7	0	0	4
11	0	0	28	12	24	1 527	20	4	0	12	0
12	0	0	26	37	152	140	26	4	0	115	0
13	0	0	0	0	99	7	7	0	0	234	0
14	21	0	117	124	241	2 204	103	10	0	83	3
15	0	0	0	412	82	599	15	0	0	15	0
16	0	0	43	292	64	521	21	0	0	29	0
17	0	0	36	36	0	2 901	16	0	0	0	0
18	0	0	168	3 034	13	4 301	139	7	0	0	0
19	0	0	18	77	117	126	63	0	0	180	0
20	0	0	6	314	221	279	12	0	0	0	0
21	0	0	17	44	252	940	35	0	0	731	0
22	0	0	71	466	33	679	96	0	0	12	21
23	0	0	69	8 244	23	1 230	88	0	0	46	54
24	0	0	8	2 149	0	839	67	0	0	34	8
25	0	0	18	150	0	1 056	171	0	0	29	0
26	0	0	30	75	60	0	60	11	0	179	0
27	0	0	14	174	301	488	75	0	0	150	19
28	0	0	15	407	0	7 657	422	0	0	0	0
29	0	0	35	495	0	5 928	1 106	4	0	0	8
30	0	0	22	332	0	2 128	262	7	0	15	22
31	0	0	4	243	4	3 358	31	0	0	62	12
32	0	0	0	2 323	0	10	0	0	0	0	21
33	0	0	0	310	32	21	11	0	11	0	11
34	0	3	0	175	0	2 074	207	26	0	26	0
35	0	0	8	49	0	5 628	572	0	0	0	0
36	0	0	17	173	0	2 550	249	3	0	0	3
37	0	0	5	811	56	298	19	0	0	56	0
38	0	0	0	1 248	110	0	0	0	0	195	0
39	0	0	8	34	0	241	151	0	0	0	0
Mean	0.5	0.9	26.6	833.0	52.7	1 430.7	116.6	2.8	0.6	64.7	5.1
Std. dev.	3.3	3.9	35.0	1 660.0	79.3	1 817.4	202.0	5.0	2.1	126.3	10.5
Minimum	0	0	0	0	0	0	0	0	0	0	0
Maximum	21	22	168	8 244	301	7 657	1 106	26	11	731	54
n	39	39	39	39	39	39	39	39	39	39	39

Table 5. (Continued).

STATION	Sand lance	Snailfish	Blenny	Windowpane flounder	Winter flounder	Witch flounder	Broken larvae	Not identified
1	0	4	55	0	0	0	4	0
2	0	0	56	0	4	0	0	0
3	7	0	588	0	160	0	0	0
4	0	0	26	0	7	0	0	0
5	0	3	14	0	10	0	0	10
6	0	0	10	27	0	0	0	0
7	0	0	19	0	50	0	19	44
8	0	0	64	7	81	54	27	0
9	0	0	101	0	8	0	0	0
10	0	0	14	0	0	0	0	0
11	0	0	16	0	0	0	4	8
12	0	0	74	0	0	0	4	26
13	0	0	57	0	0	0	0	0
14	0	0	107	0	34	41	3	14
15	0	0	71	0	30	0	0	0
16	0	0	175	0	0	29	0	7
17	0	0	12	0	0	0	4	0
18	0	0	36	20	0	7	7	0
19	5	0	117	5	0	0	0	5
20	0	0	157	6	0	0	12	29
21	0	0	191	0	0	0	0	9
22	0	0	21	4	12	0	12	12
23	0	0	115	8	0	4	4	4
24	0	0	130	84	0	0	8	4
25	0	0	350	0	0	0	0	0
26	0	0	78	0	0	60	0	22
27	0	0	80	38	0	0	0	5
28	0	0	19	30	0	0	0	0
29	0	0	19	61	0	0	0	15
30	0	0	36	29	0	0	0	7
31	0	0	15	62	0	0	0	0
32	0	0	62	0	10	83	5	0
33	0	0	139	11	0	21	0	27
34	0	0	16	0	0	0	0	13
35	0	0	0	211	0	0	90	0
36	0	0	0	222	0	0	3	0
37	0	0	14	0	0	75	0	5
38	0	0	18	0	0	0	0	18
39	0	0	64	90	0	0	0	0
Mean	0.3	0.2	80.5	23.4	10.5	9.6	5.3	7.3
Std. dev.	1.4	0.9	108.0	51.2	29.4	22.0	15.1	10.4
Minimum	0	0	0	0	0	0	0	0
Maximum	7	4	588	222	160	83	90	44
n	39	39	39	39	39	39	39	39

Table 6. Parameters of the isotropic variograms used to calculate the abundance estimates of some eggs and larvae from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

SPECIES	MODEL*	Nugget (C_0)	Sill ($C_0 + C$)	Range (A_0)	R^2	RSS: residual sum of square
EGGS						
American plaice	Exponential	6	34	5.0	0.94	1.930E+00
Atlantic mackerel	Spherical	11400	59620	18.6	0.93	3.984E+07
CHW	Exponential	62400	230000	32.2	0.88	4.750E+01
CYT	Spherical	10000	23030000	14.4	0.87	1.416E+13
H4B	Spherical	100	266000	47.5	0.96	3.543E+09
LARVAE						
Atlantic herring	Spherical	0.01	19.59	7.5	0.97	1.260E-02
Atlantic mackerel	Spherical	1	513	12.1	0.71	1.659E+04
Blenny	Exponential	4930	13080	17.3	0.84	2.847E+06
Capelin	Spherical	500	61200	18.5	0.96	1.800E+07
Cod	Spherical	10	7396	18.9	0.86	2.526E+06
Cunner	Spherical	11990000	2881000	24.2	1.00	4.226E+08
Fourbeard rockling	Spherical	3900	35580	18.3	1.00	1.474E+05
Radiated shanny	Spherical	20.7	135	24.8	0.93	6.620E+01
Righteye flounder	Spherical	354	2698	23.8	1.00	9.810E+00
Windowpane flounder	Spherical	1	1627	10.4	0.59	1.229E+05

* Spherical model $\gamma(h) = 1.5\frac{h}{A_0} - 0.5\left(\frac{h}{A_0}\right)^3$ if $h \le A_0$, and 1 otherwise

Exponential model $\gamma(h) = 1 - \exp(-\frac{3h}{A_0})$

Table 7. Abundance estimates (number /1000 m^3) of some eggs and larvae calculated by kriging from the samples collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

	KRIGING			95% CONFIDENCE INTERVAL	
	Average	**Std. Dev.**	**CV**	**Lower Limit**	**Upper Limit**
EGGS					
American plaice	1.48	0.85	0.57	0.00	3.15
Atlantic mackerel	295.05	26.35	0.09	243.40	346.69
CHW	379.16	54.84	0.14	271.66	486.65
CYT	5356.83	960.54	0.18	3474.17	7239.48
H4B	435.19	50.69	0.12	335.83	534.55
LARVAE					
Atlantic herring	2.75	0.52	0.19	1.73	3.77
Atlantic mackerel	25.35	2.35	0.09	20.75	29.96
Blenny	76.93	14.96	0.19	47.60	106.26
Capelin	738.11	147.03	0.20	449.94	1026.28
Cod	52.57	7.79	0.15	37.29	67.84
Cunner	1313.21	206.25	0.16	908.95	1717.47
Fourbeard rockling	111.99	19.14	0.17	74.48	149.49
Radiated shanny	4.22	1.13	0.27	2.01	6.43
Righteye flounder	72.36	14.11	0.20	44.70	100.02
Windowpane flounder	24.04	4.30	0.18	15.61	32.47

Table 8. Characteristics of the water temperature (°C) for the groups of stations defined by cluster analysis.

GROUP	AVERAGE SIMILARITY	STATION	DEPTH (m)	n	TEMPERATURE (°C) Min.	Mean	Max.	S.D.	Range
a	92.47	10, 11, 17, 28, 31, 35	≤ 2 m	24	14.18	15.10	16.77	0.99	2.60
			≤ 5 m	66	13.88	14.99	16.77	0.99	2.89
			≤ 10 m	131	13.36	14.71	16.77	0.98	3.42
			≤ 15 m	162	11.19	14.38	16.77	1.17	5.59
b	Less than 2 stations in group	14	≤ 2 m	2	15.28	15.32	15.37	0.07	0.09
			≤ 5 m	8	14.68	15.06	15.37	0.24	0.69
			≤ 10 m	18	14.18	14.67	15.37	0.41	1.19
			≤ 15 m	28	13.92	14.44	15.37	0.45	1.45
c	89.51	6, 7, 29, 30, 34, 36	≤ 2 m	22	15.45	16.10	17.01	0.52	1.56
			≤ 5 m	58	15.15	15.91	17.01	0.51	1.86
			≤ 10 m	111	12.18	15.40	17.01	0.90	4.83
			≤ 15 m	151	10.94	15.01	17.01	1.23	6.07
d	70.73	9, 15, 16 18, 20, 22, 25, 39	≤ 2 m	27	14.45	15.14	16.23	0.51	1.78
			≤ 5 m	74	13.97	14.91	16.23	0.53	2.26
			≤ 10 m	150	13.11	14.60	16.23	0.63	3.13
			≤ 15 m	219	12.00	14.25	16.23	0.89	4.23
e	78.98	2, 8, 23 24, 32, 37, 38	≤ 2 m	16	13.96	14.53	15.75	0.54	1.79
			≤ 5 m	53	13.81	14.33	15.75	0.46	1.94
			≤ 10 m	123	13.01	14.07	15.75	0.52	2.75
			≤ 15 m	188	11.18	13.66	15.75	0.91	4.57
f	55.24	1, 3, 4 5, 12, 13, 19, 21, 26 27, 33	≤ 2 m	40	13.90	14.49	17.33	0.76	3.43
			≤ 5 m	106	13.71	14.34	17.33	0.58	3.62
			≤ 10 m	216	13.00	14.09	17.33	0.59	4.33
			≤ 15 m	321	11.52	13.80	17.33	0.75	5.81

Table 9. Characteristics of the water salinity for the groups of stations defined by cluster analysis.

GROUP	AVERAGE SIMILARITY	STATION	DEPTH (m)	SALINITY				
				n	Min.	Mean	Max.	S.D.	Range
a	92.47	10, 11, 17, 28, 31, 35	≤ 2 m	24	27.24	30.64	31.16	0.91	3.92
			≤ 5 m	66	27.24	30.87	31.24	0.58	4.00
			≤ 10 m	131	27.24	30.96	31.29	0.43	4.04
			≤ 15 m	162	27.24	31.01	31.51	0.41	4.27
b	Less than 2 stations in group	14	≤ 2 m	2	30.93	30.94	30.96	0.02	0.03
			≤ 5 m	8	30.93	31.01	31.14	0.08	0.21
			≤ 10 m	18	30.93	31.12	31.22	0.11	0.30
			≤ 15 m	28	30.93	31.16	31.24	0.10	0.31
c	89.51	6, 7, 29, 30, 34, 36	≤ 2 m	22	25.96	30.27	30.88	1.13	4.92
			≤ 5 m	58	25.96	30.58	31.02	0.75	5.06
			≤ 10 m	111	25.96	30.78	31.41	0.59	5.45
			≤ 15 m	151	25.96	30.86	31.42	0.54	5.46
d	70.73	9, 15, 16 18, 20, 22, 25, 39	≤ 2 m	27	27.94	30.82	31.42	0.68	3.48
			≤ 5 m	74	27.94	30.93	31.42	0.44	3.48
			≤ 10 m	150	27.94	31.00	31.42	0.33	3.48
			≤ 15 m	219	27.94	31.06	31.44	0.30	3.50
e	78.98	2, 8, 23 24, 32, 37, 38	≤ 2 m	16	28.36	30.66	31.28	0.77	2.92
			≤ 5 m	53	28.36	30.92	31.28	0.50	2.92
			≤ 10 m	123	28.36	31.01	31.40	0.40	3.03
			≤ 15 m	188	28.36	31.09	31.53	0.35	3.17
f	55.24	1, 3, 4 5, 12, 13, 19, 21, 26 27, 33	≤ 2 m	40	27.63	30.70	31.27	0.88	3.63
			≤ 5 m	106	27.63	30.93	31.36	0.64	3.72
			≤ 10 m	216	27.63	31.05	31.39	0.49	3.75
			≤ 15 m	321	27.63	31.11	31.47	0.42	3.84

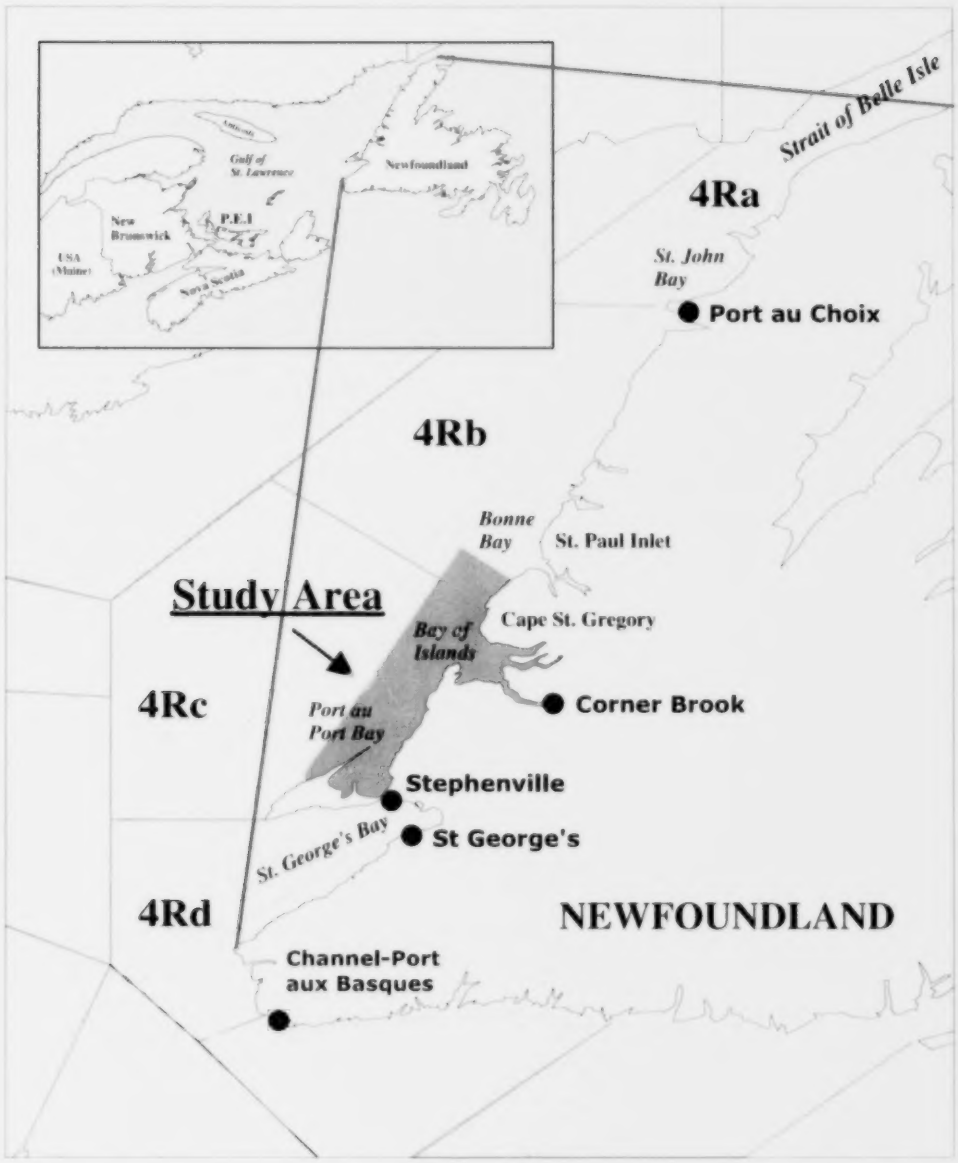


Figure 1. Map of the west coast of Newfoundland showing the study area and the other locations mentioned in the document.

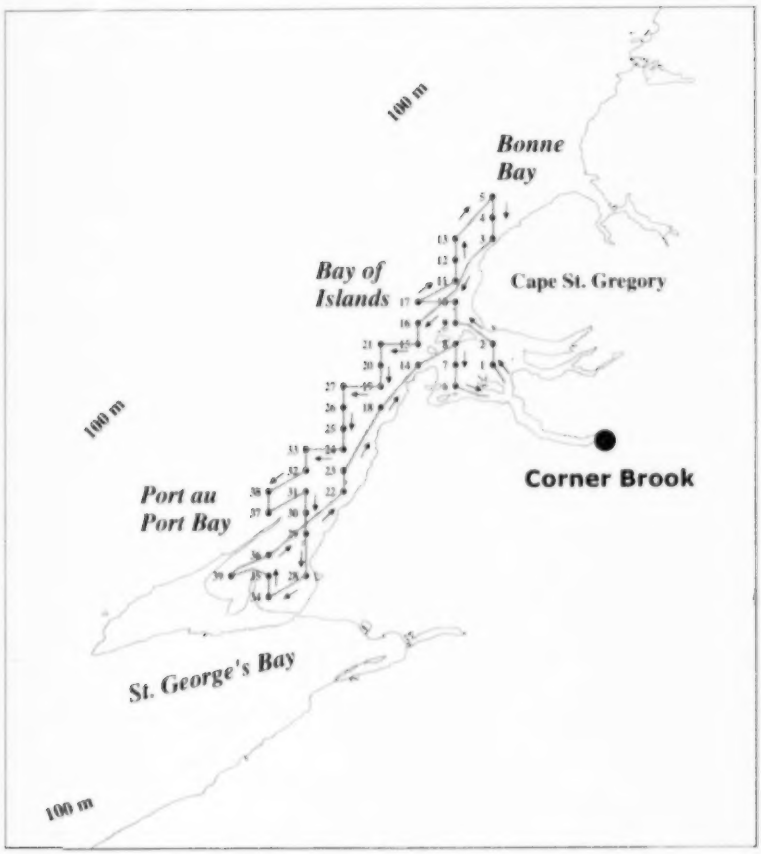


Figure 2. Map of the 39-station sampling grid of the capelin and Atlantic herring larval survey in July 2005 on the west coast of Newfoundland.

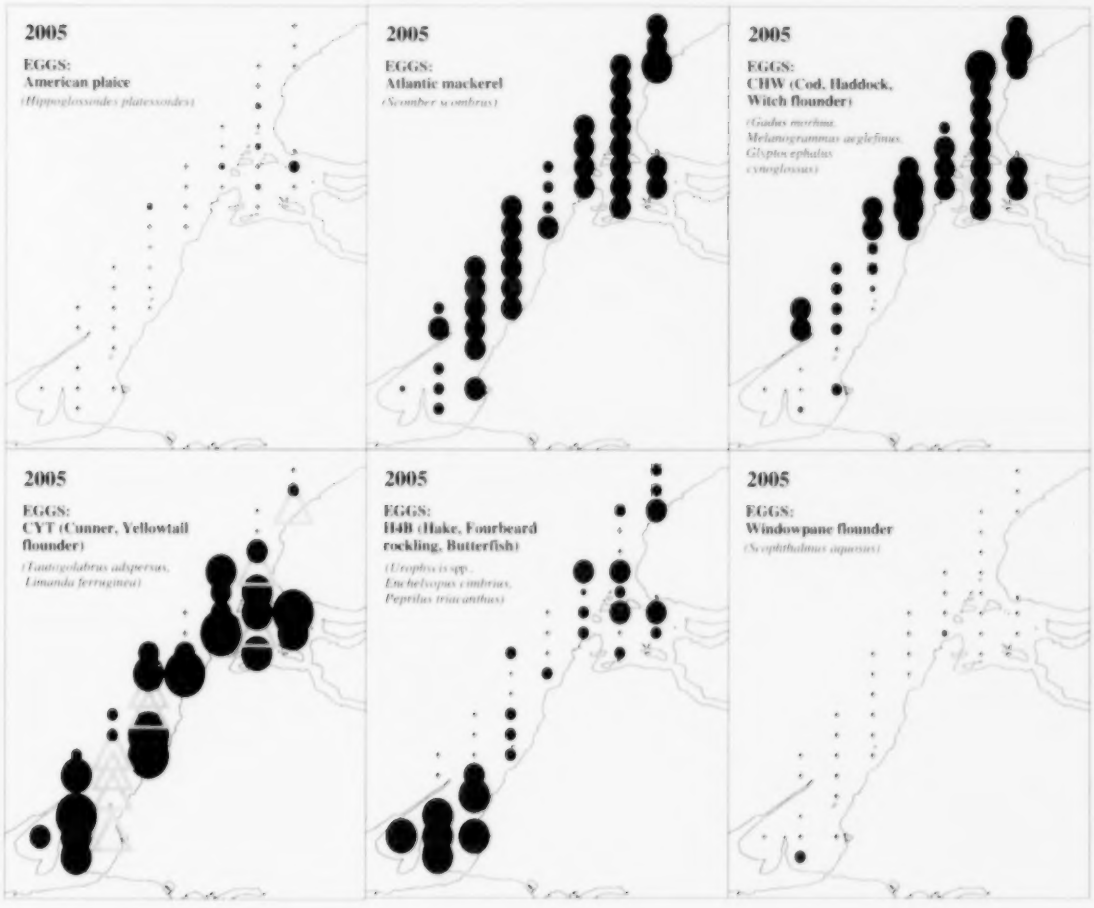


Figure 3. Maps of the egg abundance (number /1000 m^3) distributions from the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

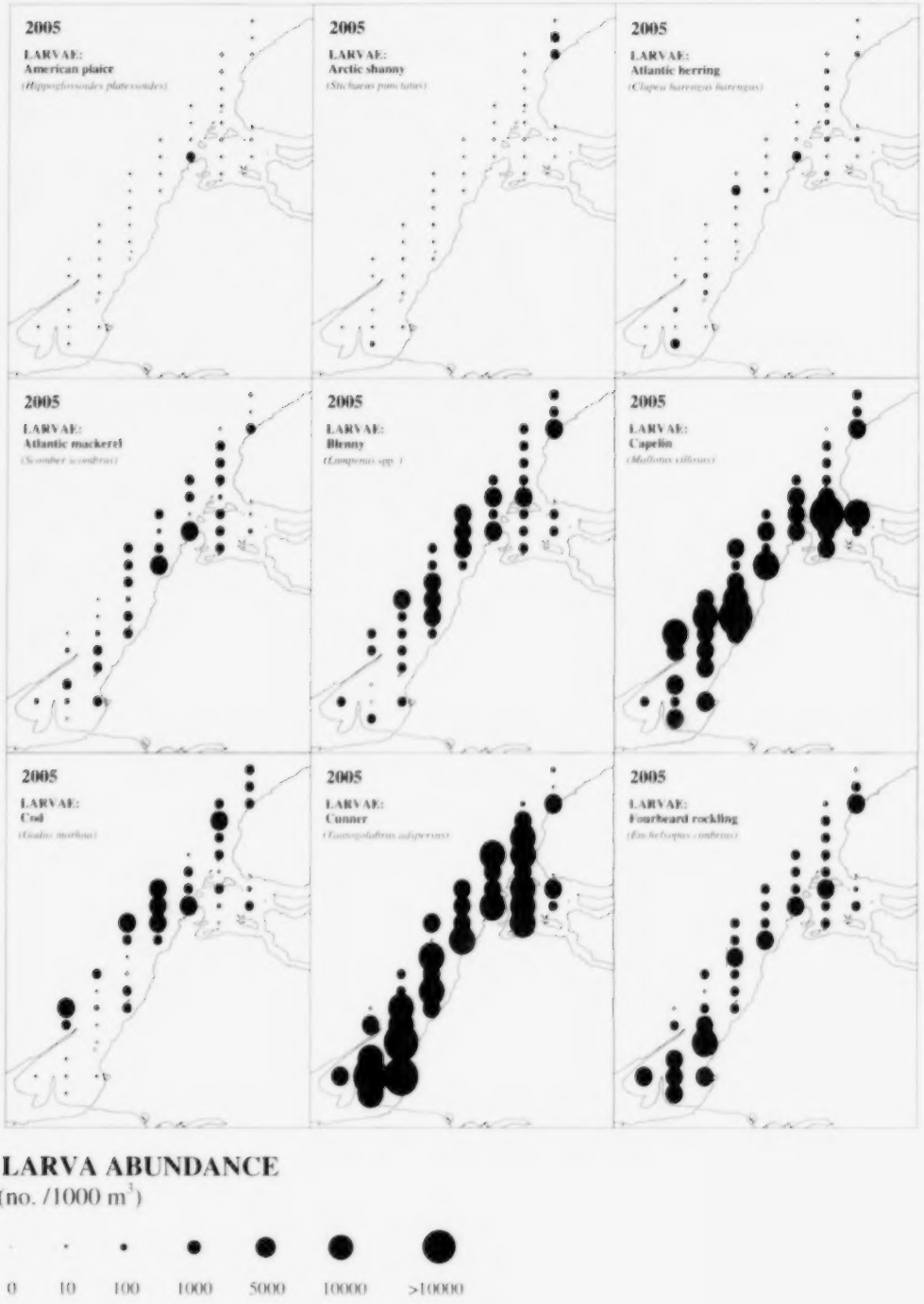


Figure 4. Maps of the larva abundance (number /1000 m^3) distributions from the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland (Note: blenny larvae were identified as capelin in Grégoire et al., 2006b; correct capelin counts by station can be determined from Tables 1 and 5 of the present document).

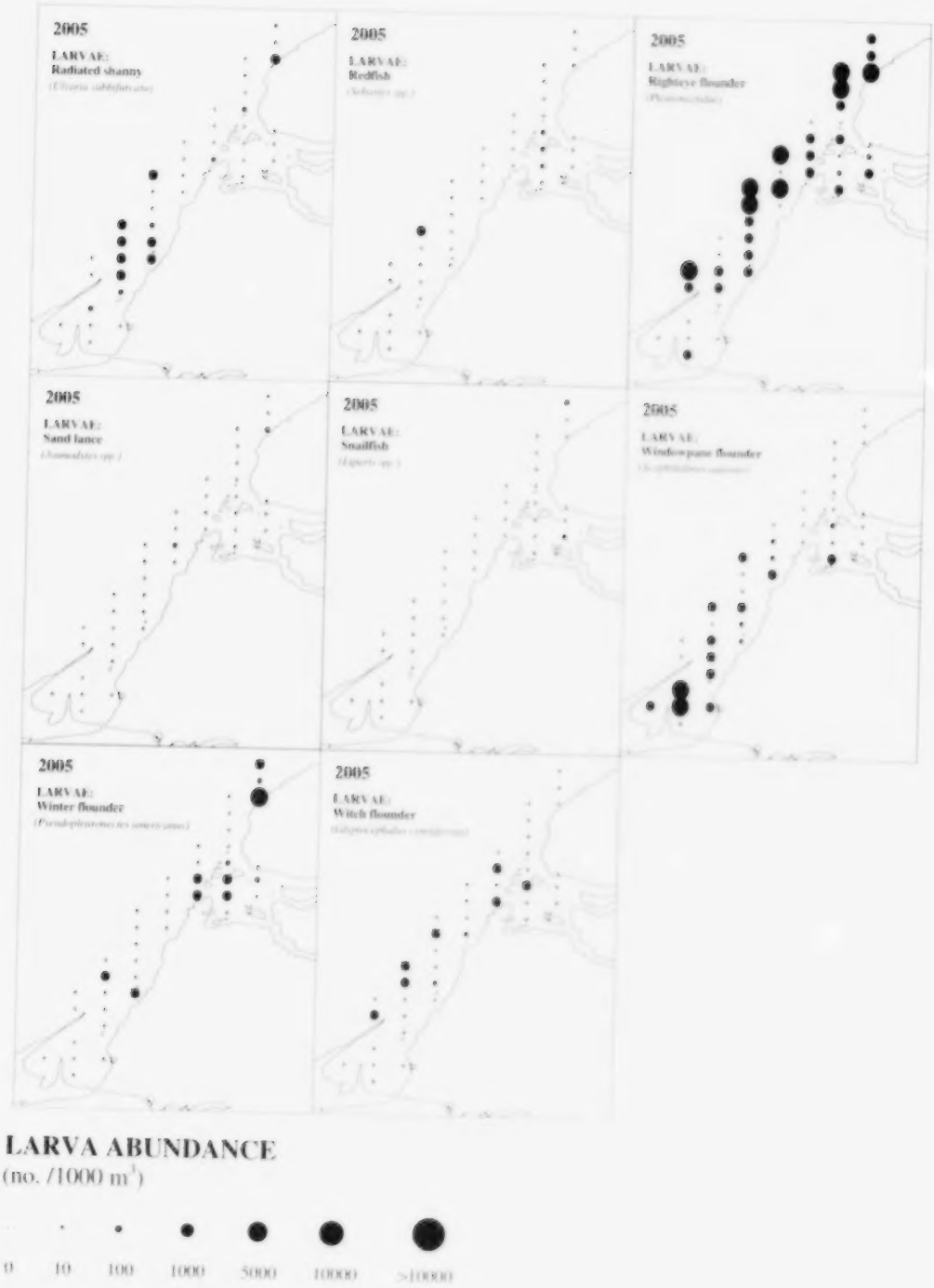


Figure 4. (Continued).

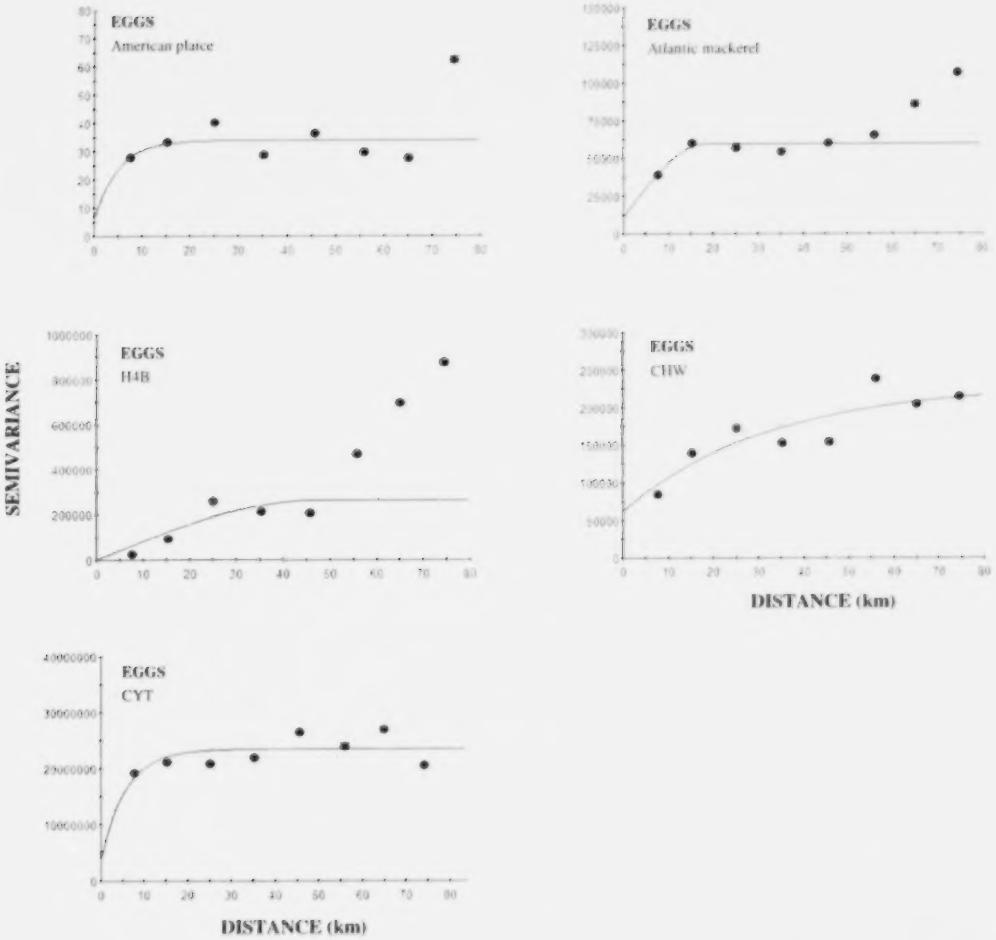


Figure 5. Isotropic variograms of abundance estimates for the eggs and larvae of some species sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland (dashed lines represent the variance of the data).

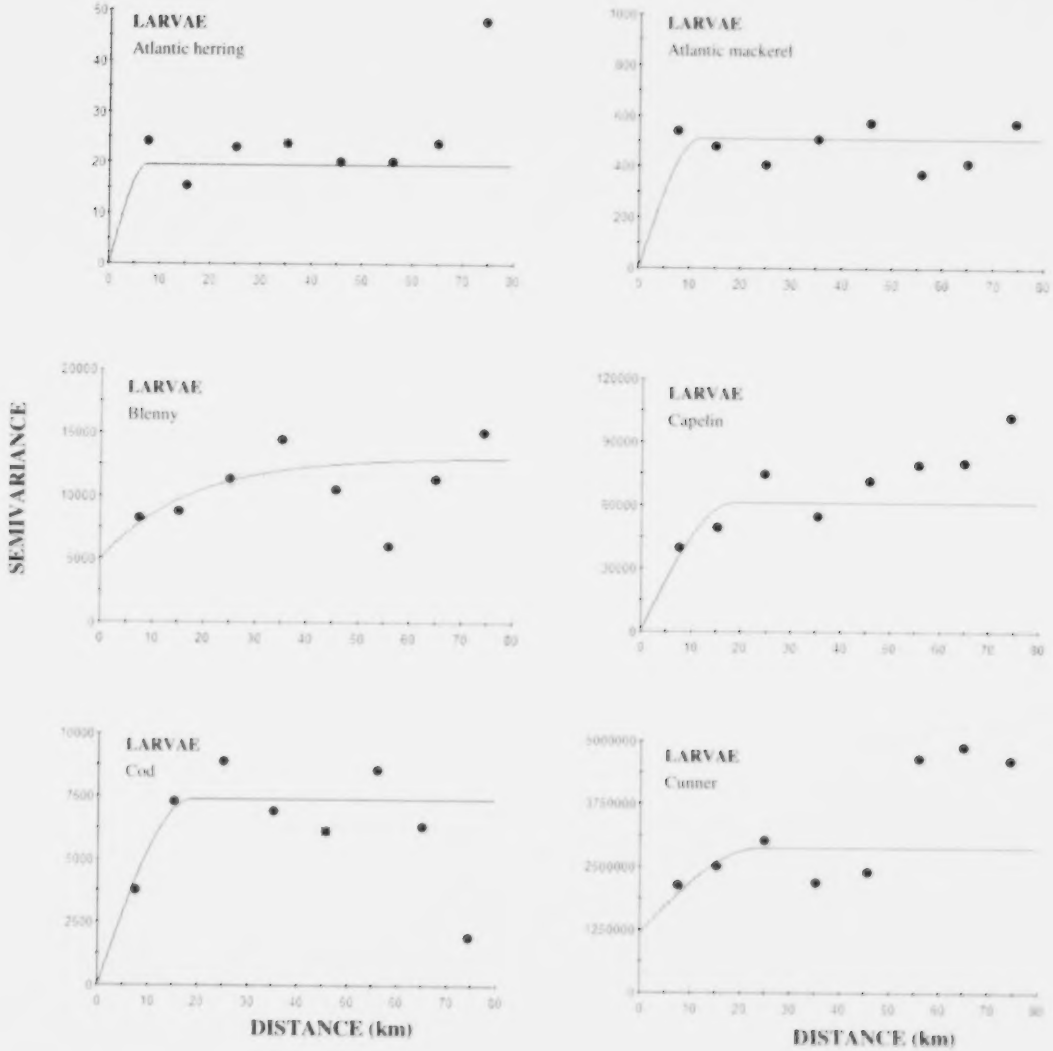


Figure 5. (Continued).

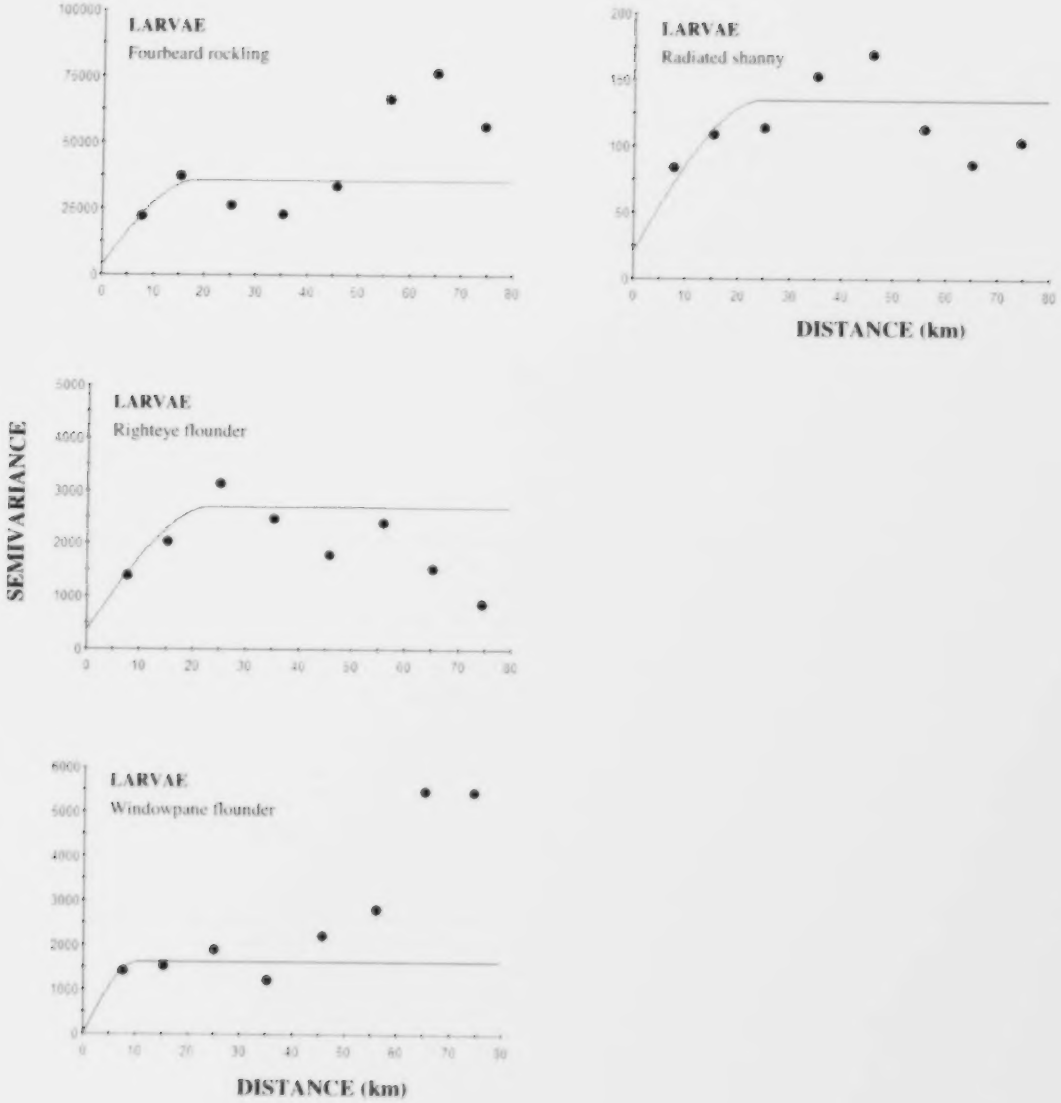


Figure 5. (Continued).

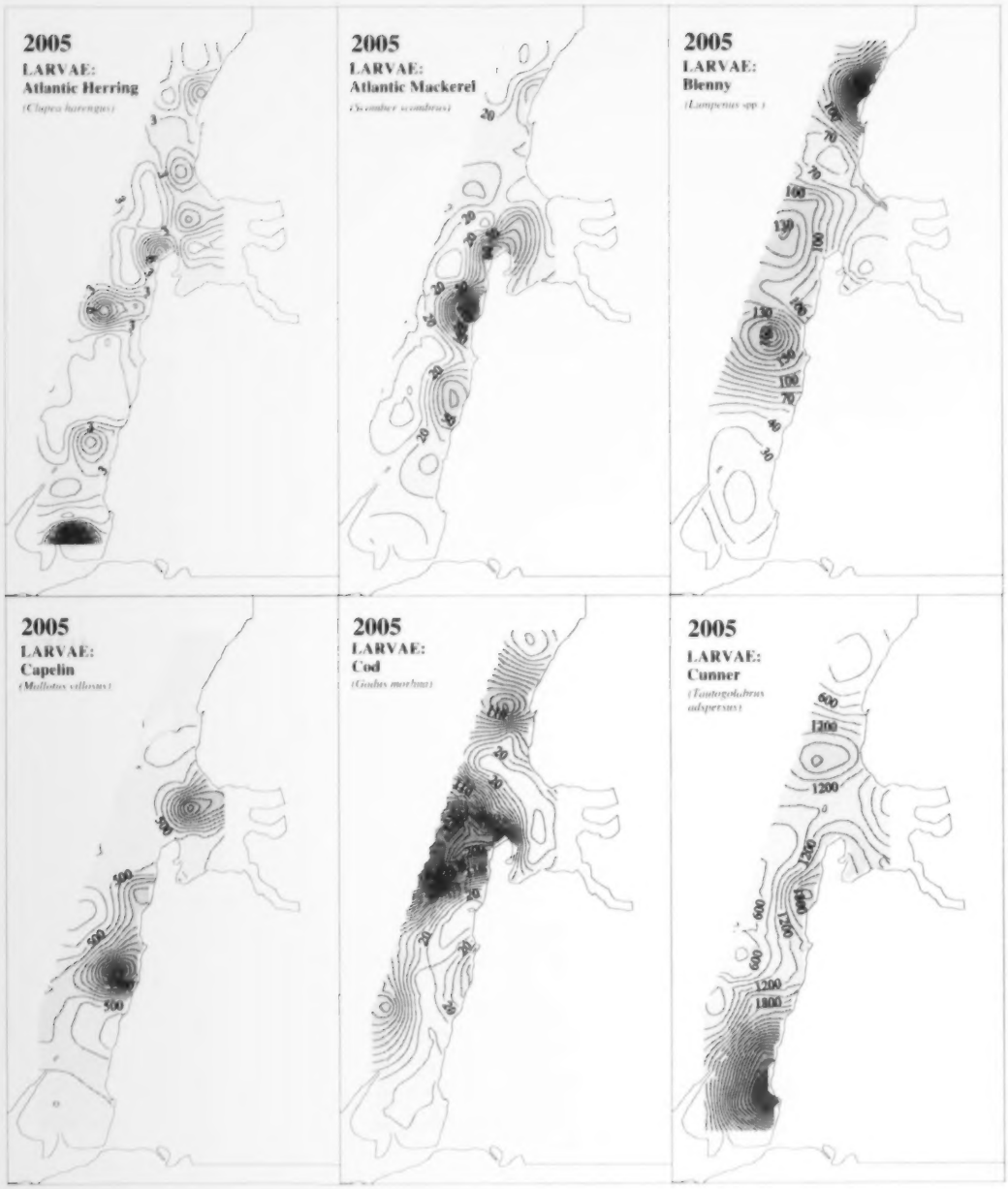


Figure 6. Abundance distribution maps (number /1000 m^3) as derived by kriging of the larvae of some species sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

Figure 6. Abundance distribution maps (number /1000 m^3) as derived by kriging of the larvae of some species sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

Figure 6. (Continued).

Figure 6. (Continued).

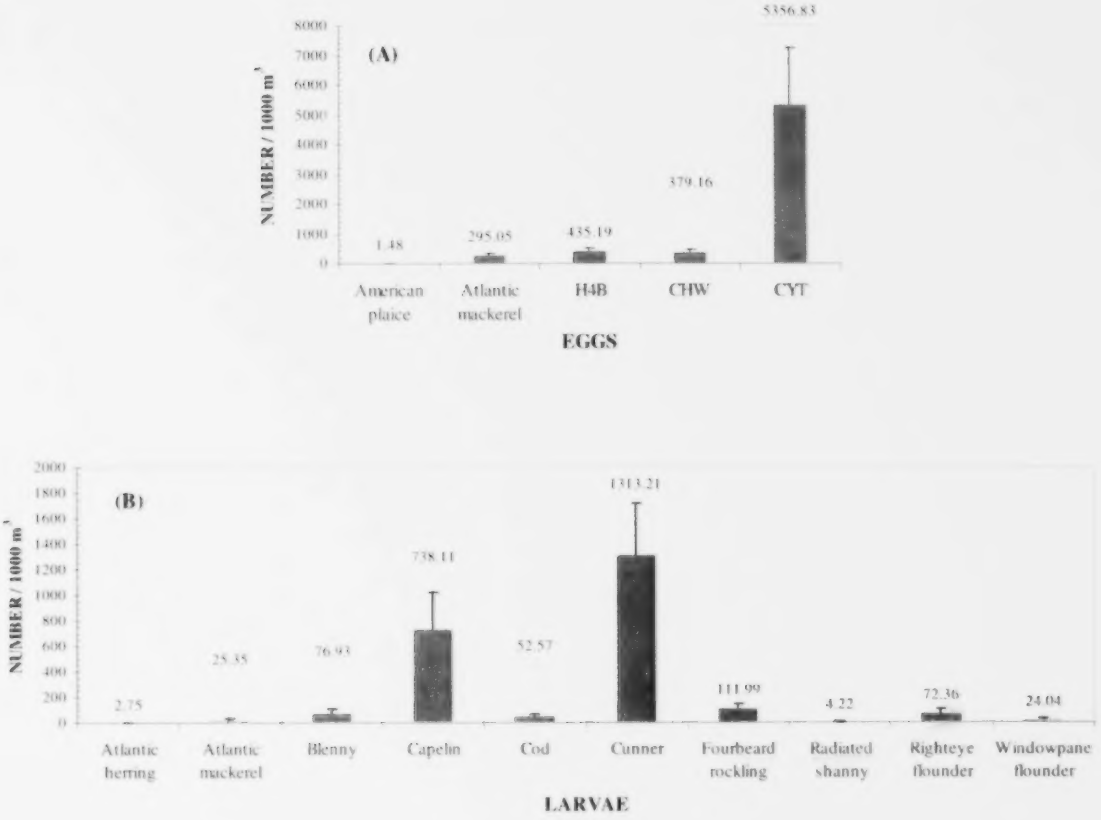


Figure 7. Mean abundance estimates (number /1000 m^3) (with 95% confidence intervals) of the eggs (A) and larvae (B) of some species sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

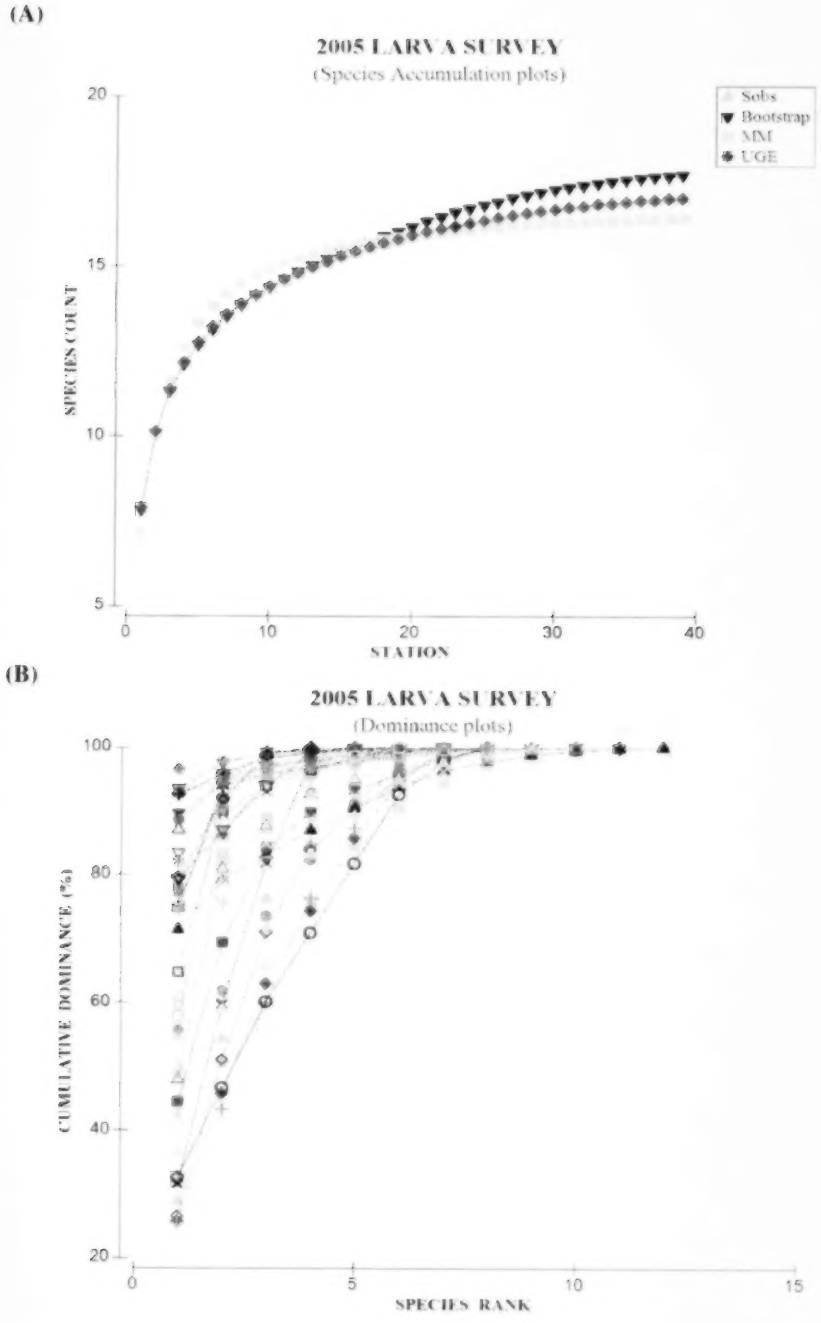


Figure 8. Species accumulation (A) and dominance (B) plots for the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland. In A, Sobs= observed data; bootstrap, MM, UGE= Predicted data; see text for explanation. In B, the line-symbols represent the cumulative dominance and species rank of each station.

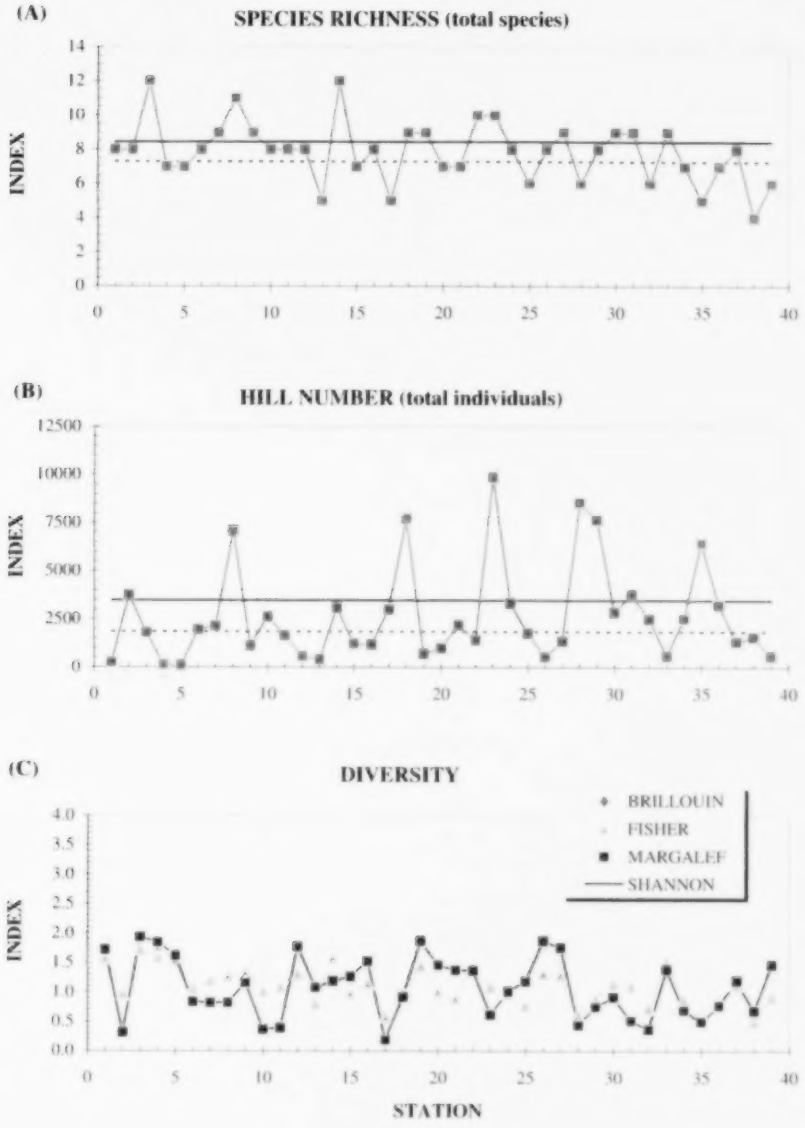


Figure 9. Total species (A), total individuals (B), and four diversity indices (C) calculated for the stations sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland. The horizontal lines in A and B indicate the upper and lower limits of the confidence interval (95%) of the mean of all stations.

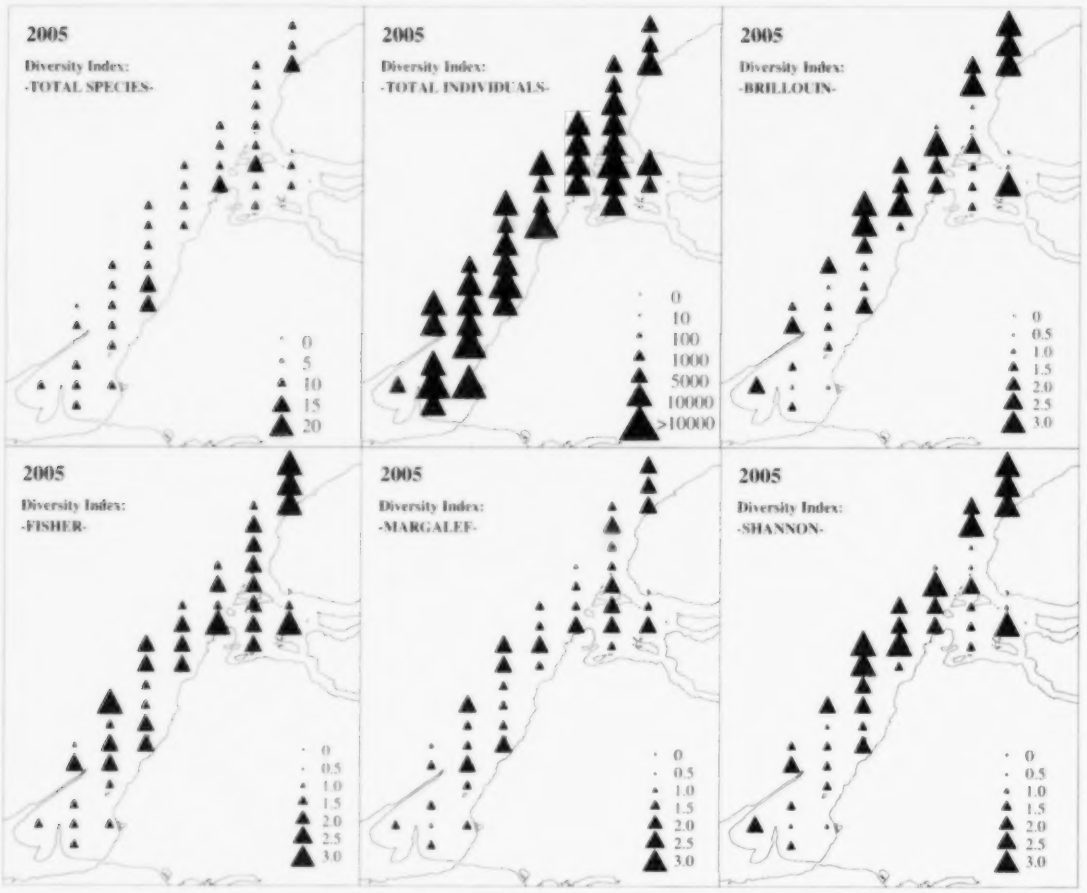
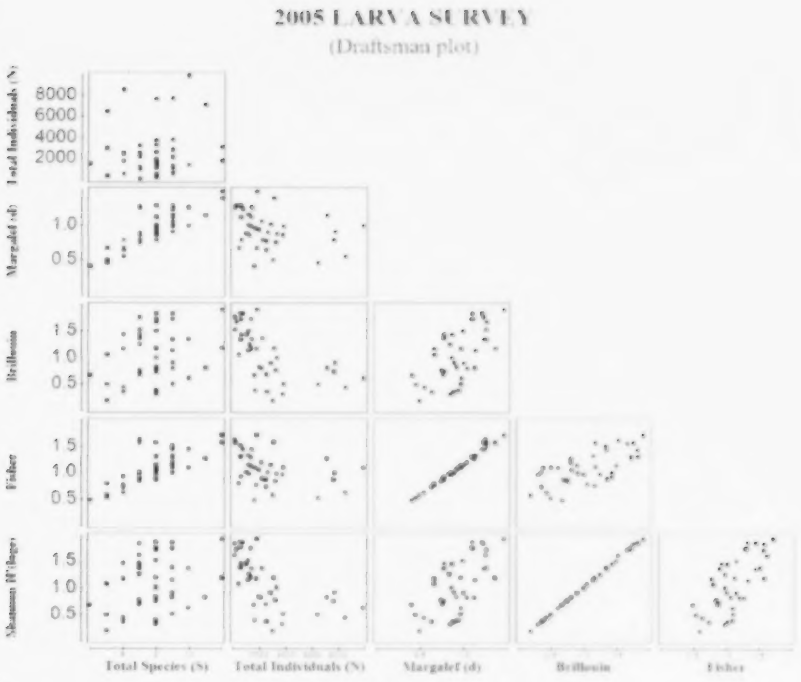


Figure 10. Maps showing distributions of total species, total individuals, and four diversity indices for the stations sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

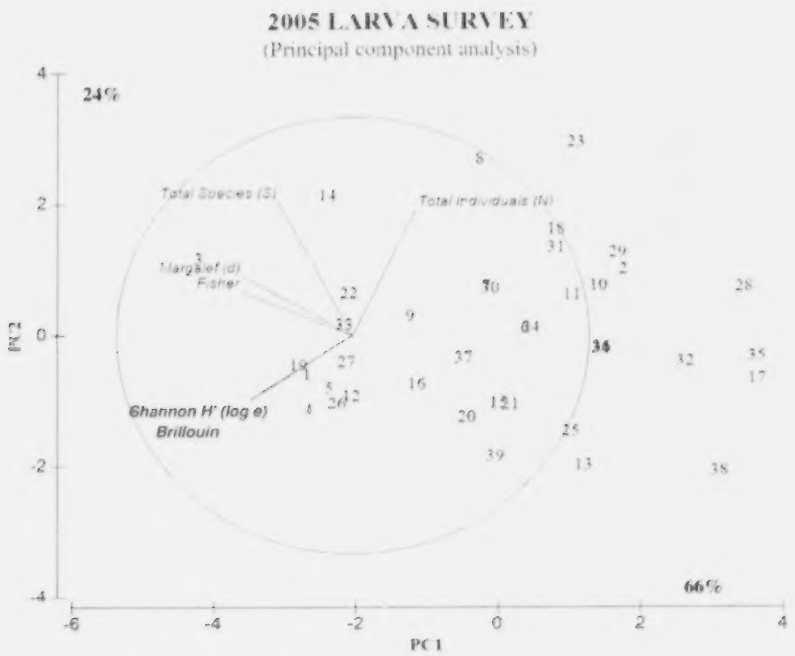
(A)



(B)

Figure 11. Draftsman (A), non-metric multidimensional scaling (B), and principal component analysis (PCA) (C) plots for the diversity indices calculated from the data collected during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

(C)



Variable	Eigenvectors PC1	PC2
Total Species (S)	-0.316	0.614
Total Individuals (N)	0.266	0.574
Margalef (d)	-0.466	0.273
Brillouin	-0.441	-0.296
Fisher	-0.472	0.201
Shannon H'(log e)	-0.442	-0.301

Figure 11. (Continued).

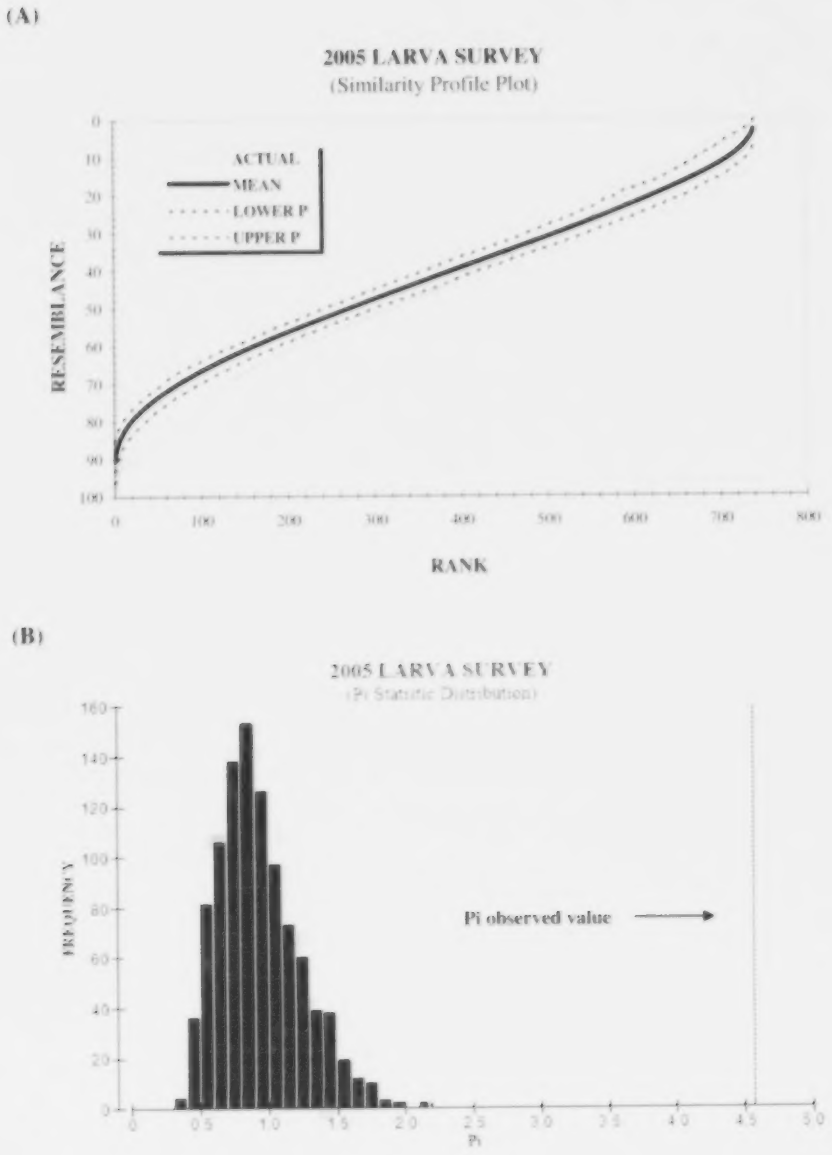


Figure 12. Similarity profile (A) and *Pi* statistic distribution (B) testing for evidence of internal group structure in the full set of stations sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland.

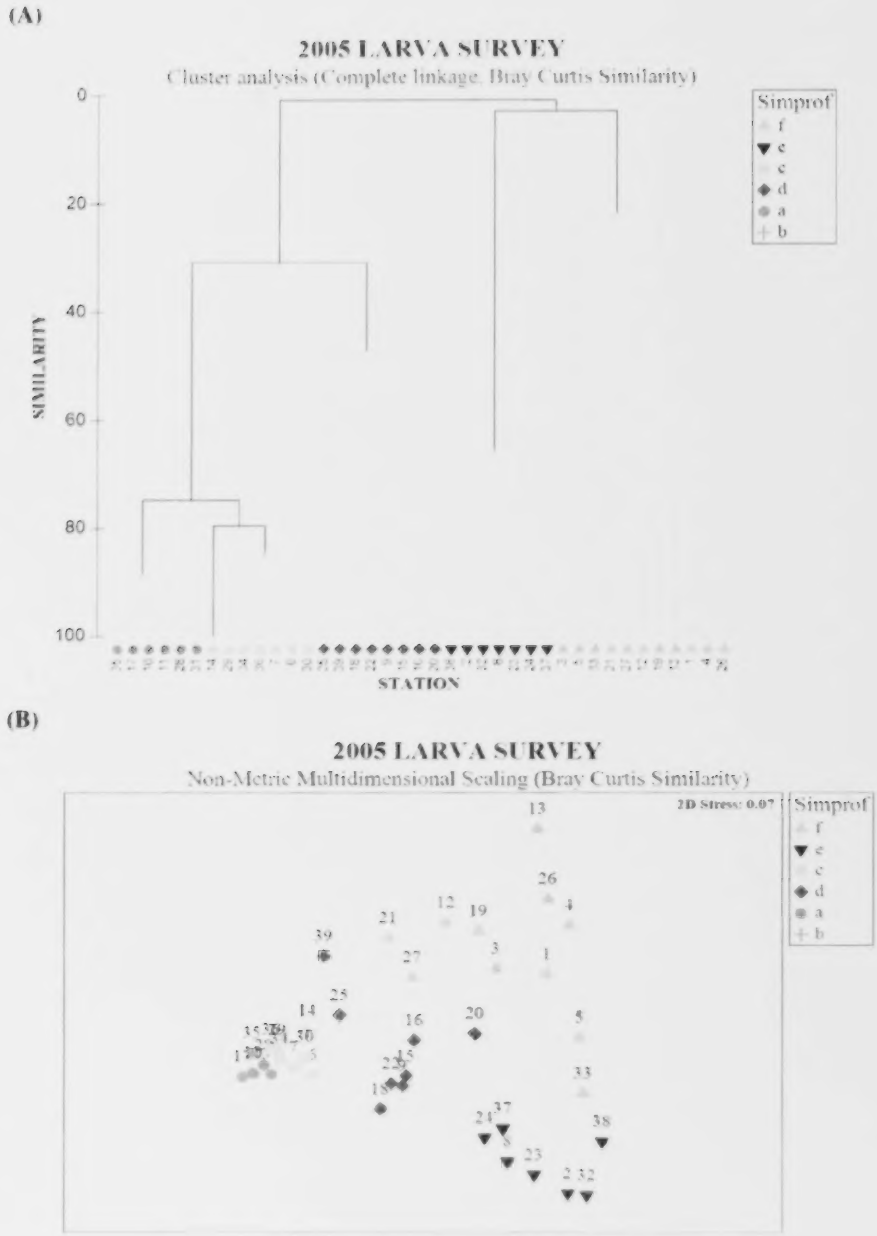


Figure 13. Results of the cluster analysis (A) and non-metric multidimensional scaling (B) applied on the Bray Curtis similarities calculated among the stations sampled during the capelin and Atlantic herring larval survey of July 2005 on the west coast of Newfoundland (groups of stations were defined by the SIMPROF procedure).

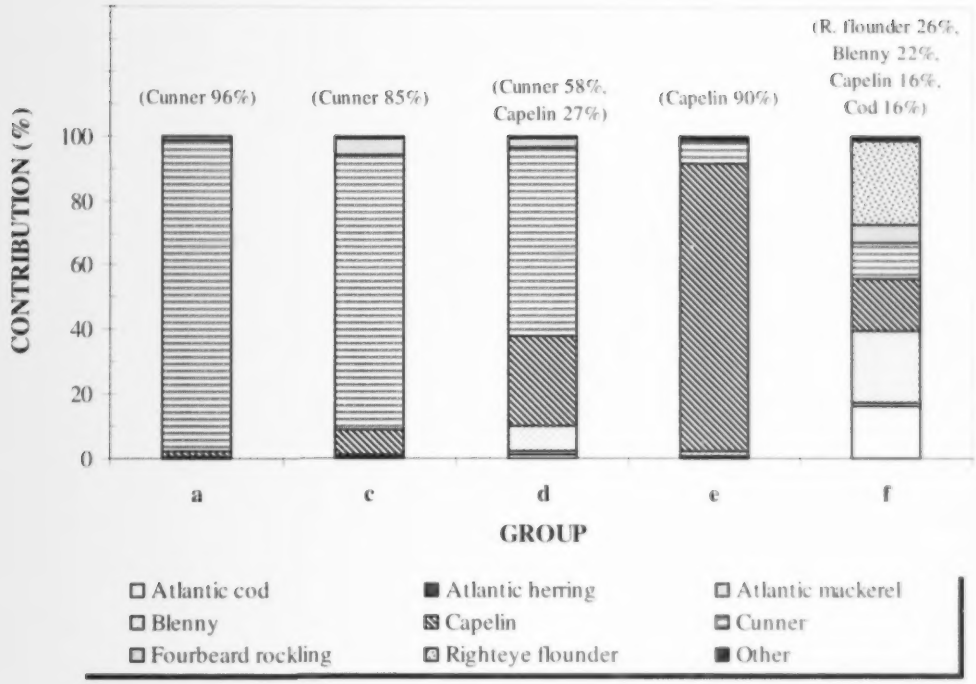


Figure 14. Relative contribution (%) of the main species of fish larvae to the similarity of each group of stations defined by cluster analysis.

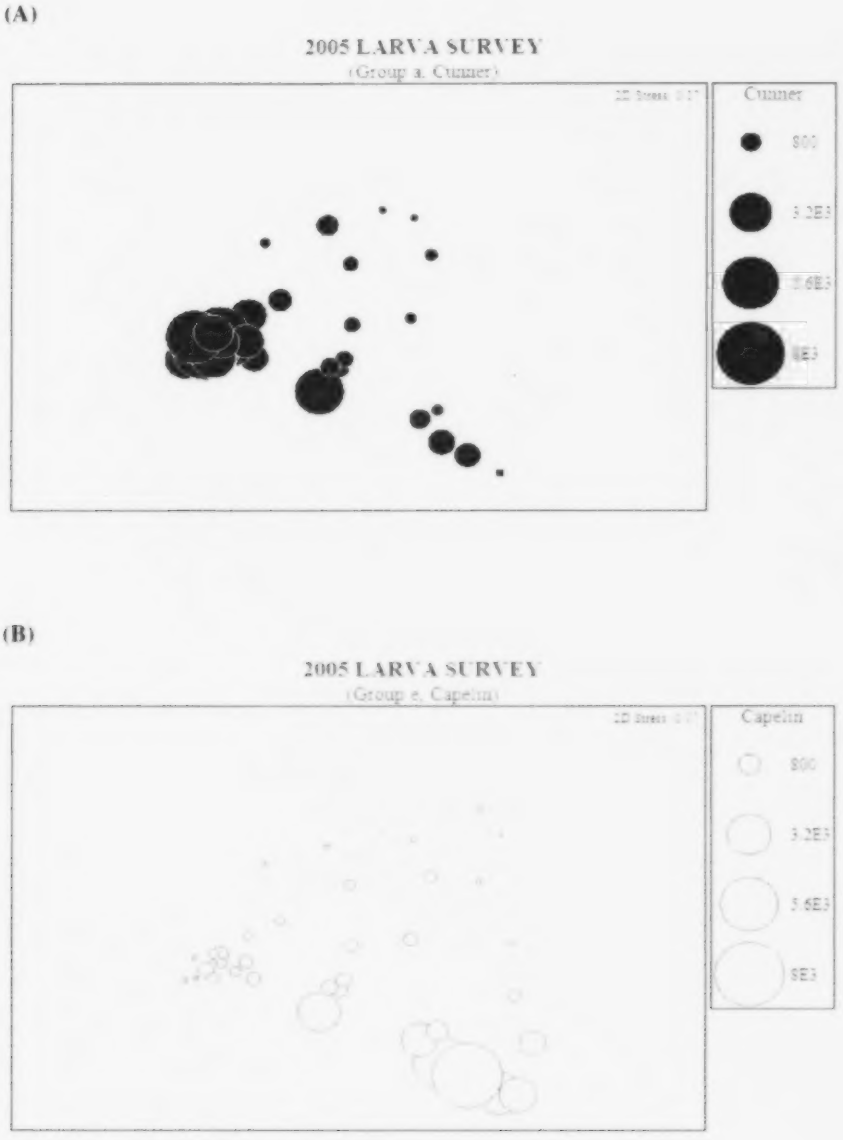


Figure 15. Non-metric multidimensional scaling showing the position and abundance (number /1000 m^3) of the two species with the greatest contribution (%) to groups a (A) and e (B).

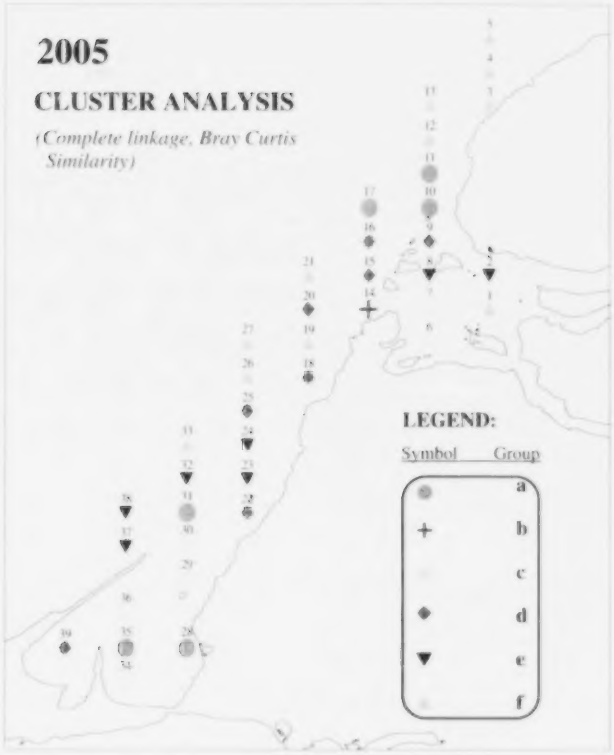


Figure 16. Map of the fish larval assemblages defined by the cluster analysis.

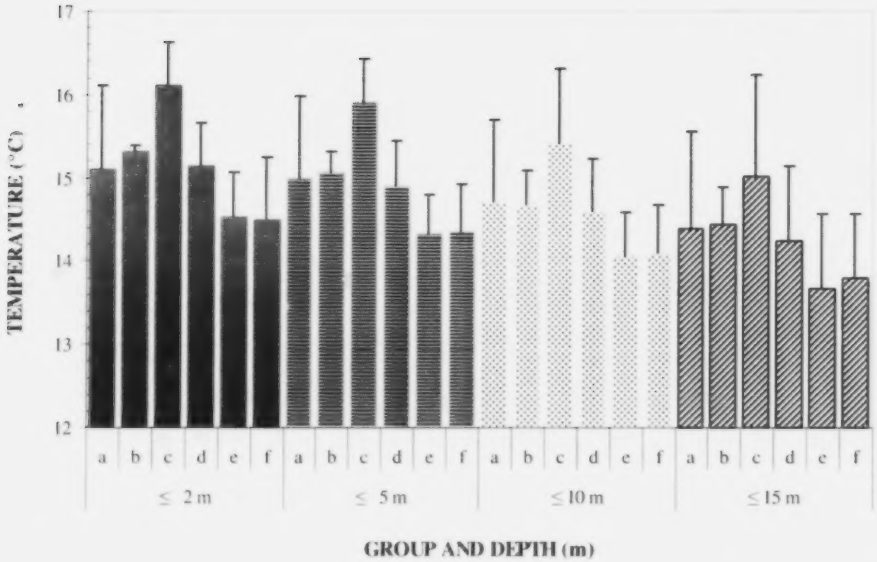


Figure 17. Average temperature (°C) by depth interval for the groups of stations defined by the cluster analysis. Standard deviations are indicated by the vertical lines.

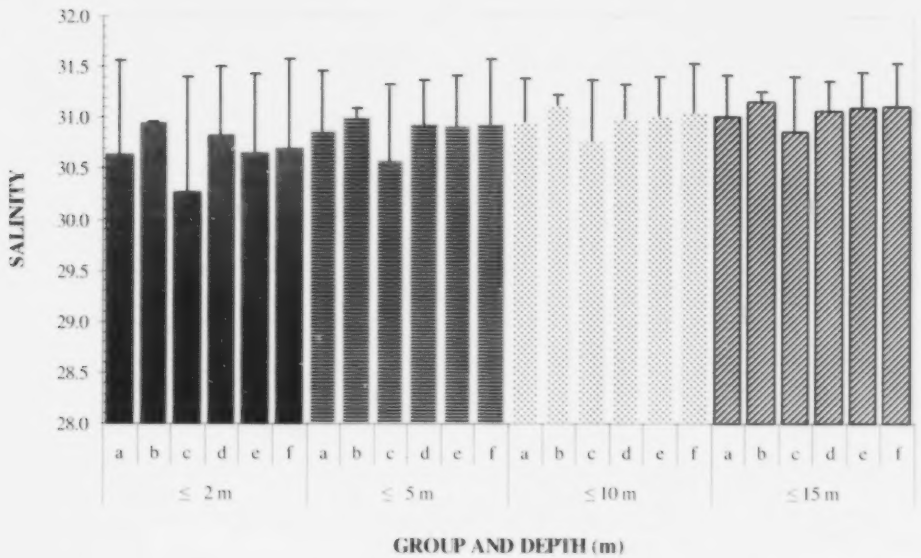


Figure 18. Average salinity by depth interval for the groups of stations defined by the cluster analysis. Standard deviations are indicated by the vertical lines.

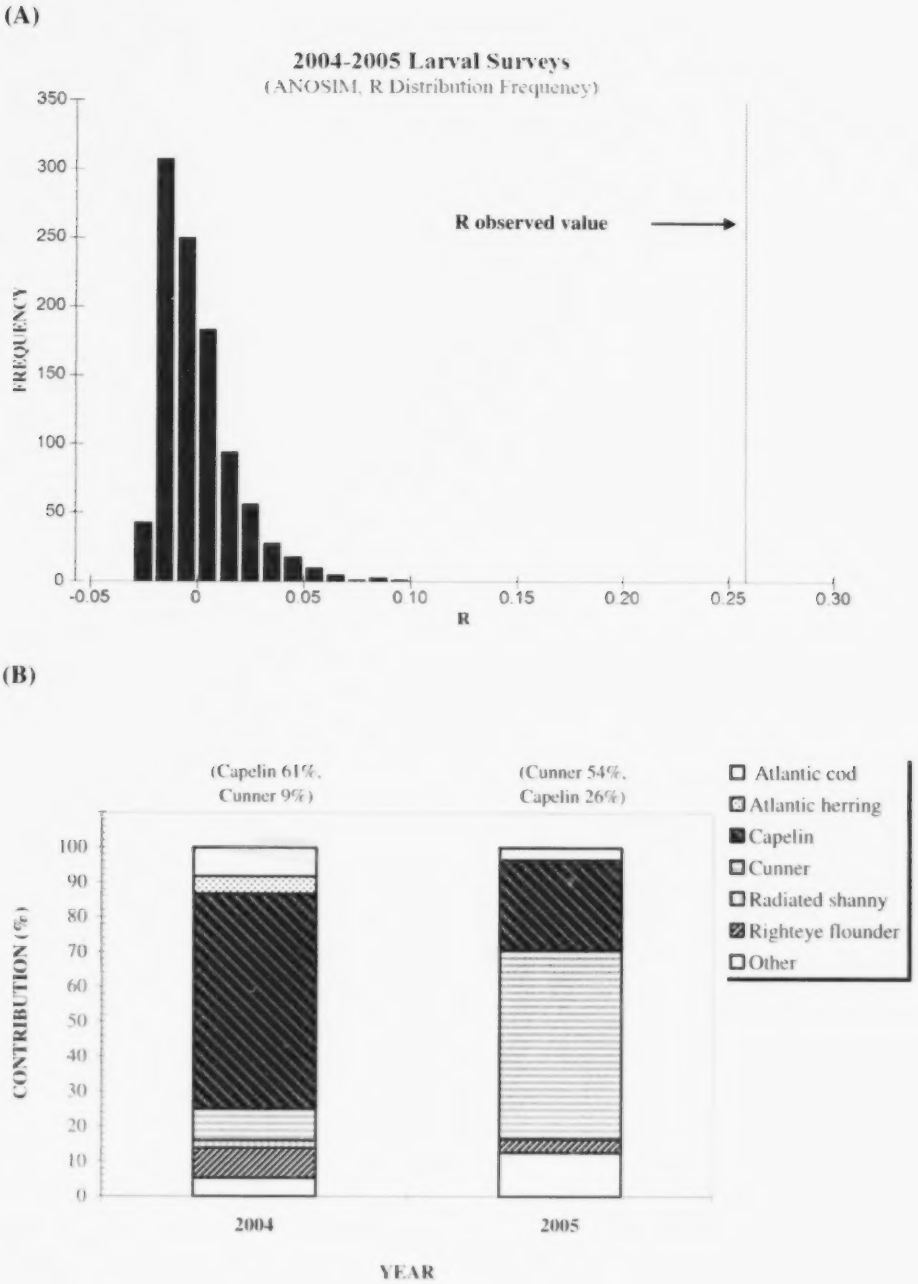


Figure 19. Results of the one-way ANOSIM procedure testing the null hypothesis that there are no larval assemblage differences between the groups of stations defined by cluster analyses and sampled in 2004 and 2005 (A) and the relative contribution (%) of the main fish larvae to the similarity of each assemblage (B).